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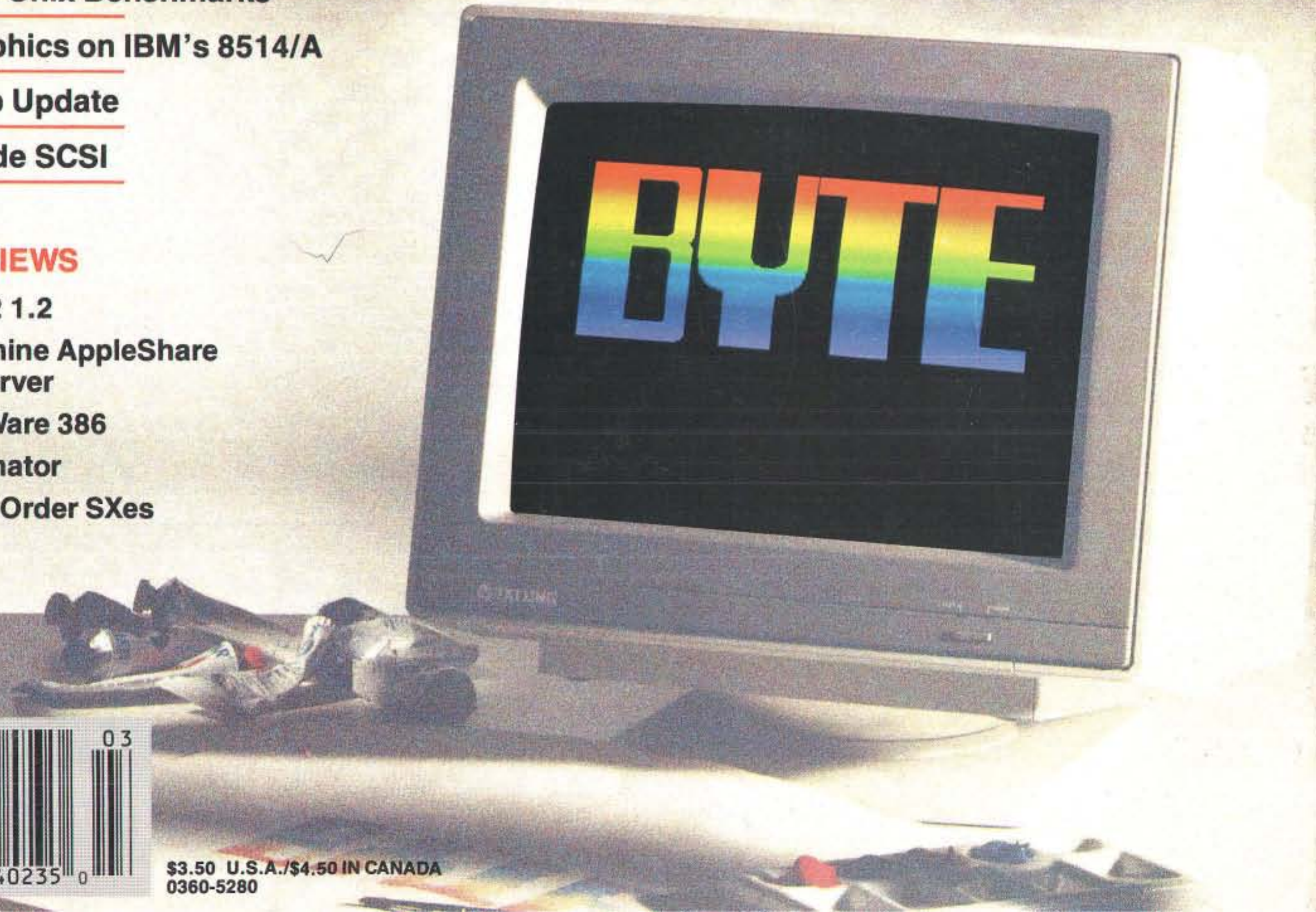
- Animator
- Mail-Order SXes



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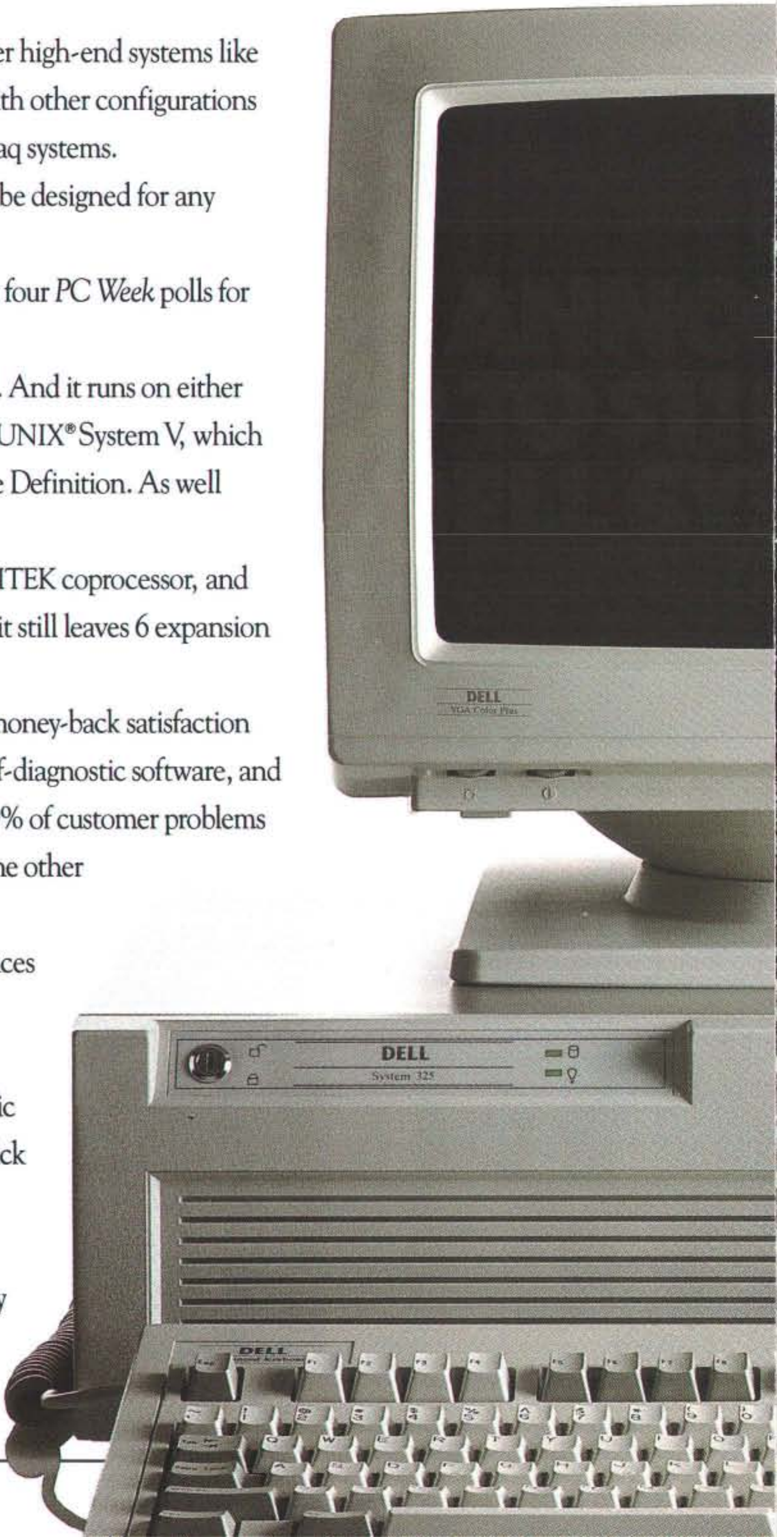

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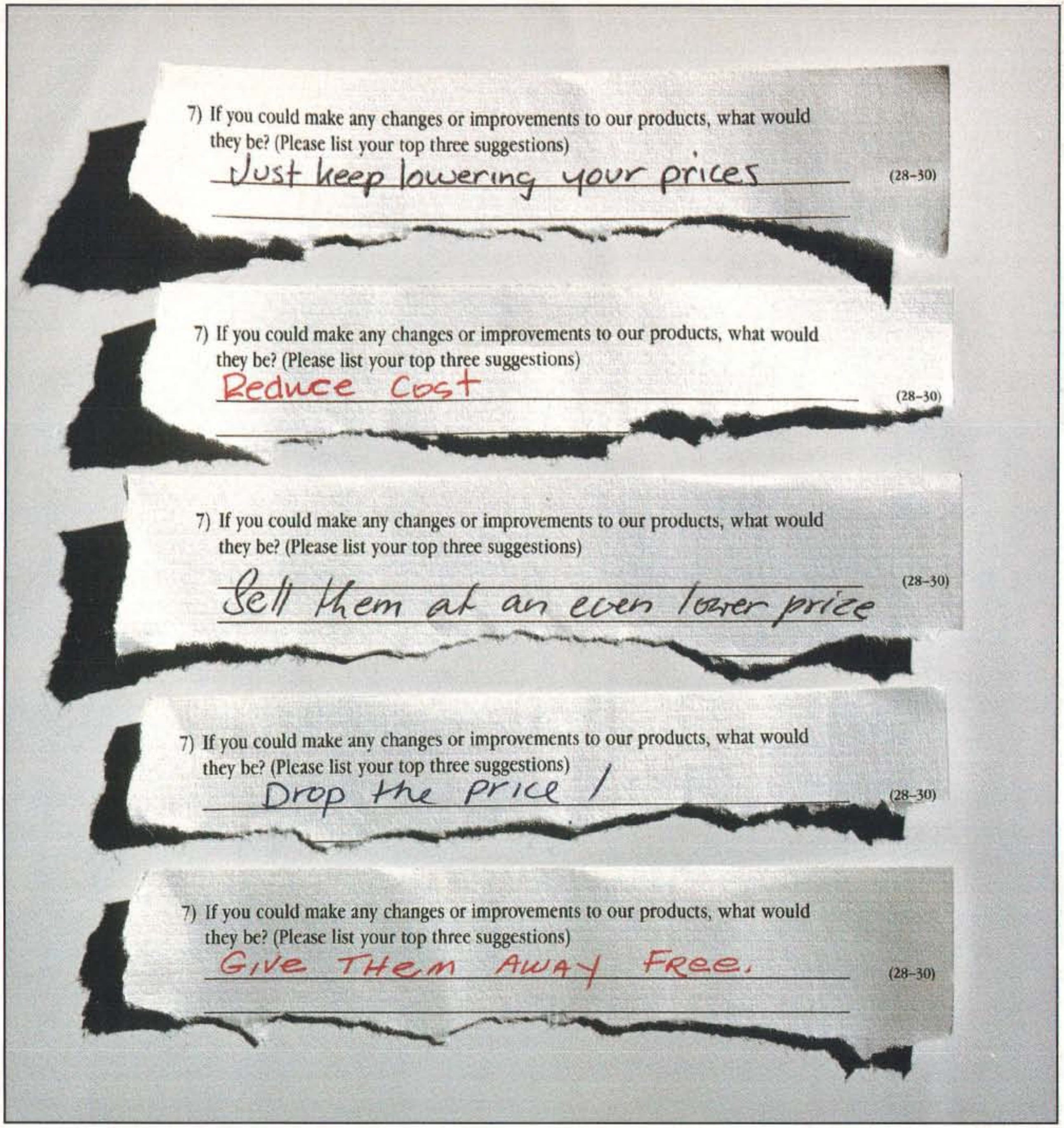

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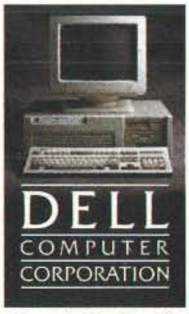

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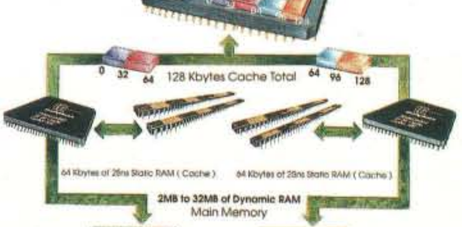
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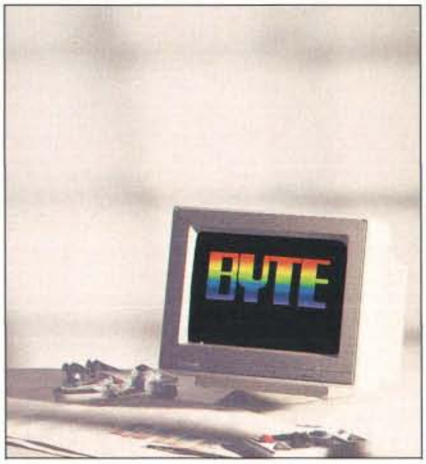

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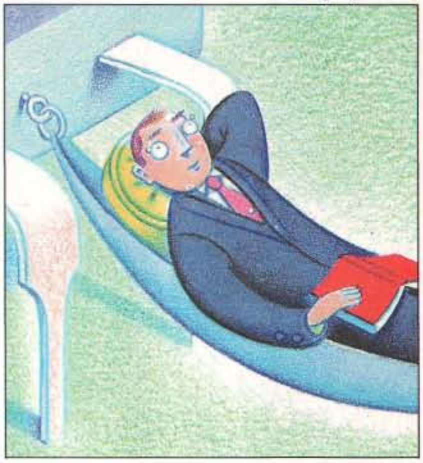

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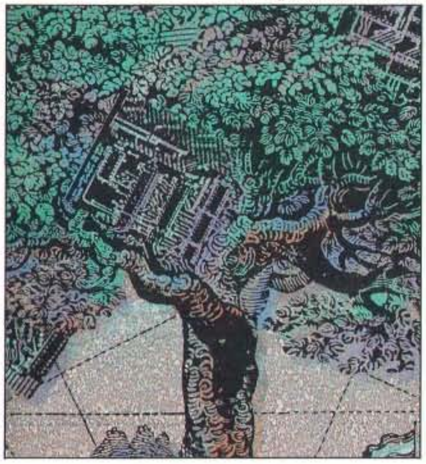

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S P O T L I G H T

Rick Grehan

Ben Smith

MASTERS OF UNIX VERSE

Creating the BYTE Unix benchmarks posed interesting challenges

Nothing worthwhile ever comes easy. For BYTE technical editor Ben Smith and Lab director Rick Grehan, that phrase has special meaning. Ben and Rick are the key architects of BYTE's new Unix benchmark suite (see "The BYTE Unix Benchmarks" on page 273).

Ben's greatest challenge was trying to establish tests that are valid for the 80286-based Xenix machines as well as significant for the high-performance multiple processor machines and new generation of RISC machines. Although Ben has six years of experience working in electronics hardware, he doesn't consider himself hardware oriented. "My focus of the last 10 years has been entirely on software development and Unix. Though I have a good appetite for fast and powerful computers, I'm much more interested in the operating system and application programs."

Since he came to BYTE, Ben has been responsible for the May 1989 Unix In Depth, setting up the BYTE Unix Lab, and keeping BYTE current with the Unix community.

Developing the Unix benchmarks was interesting for Ben because he enjoys pulling together ideas and code from other programmers into an integrated system. Even though he had to rewrite a major part of what he used, he finds it interesting to see how other people do things. "Editing other people's work is instructive because I have to thoroughly understand what I am working with before I can modify it, even comment it."

Rick wrote the database simulation portion of the Unix benchmarks. As its name implies, the benchmark simulates the operation of a multiuser database. It adheres to a client-server model, and as such is composed of two programs. The first program, the server, rides herd on a pre-built data file. The client program branches off to a user-selectable number of children tasks.

"The Unix benchmarks were a real challenge because until recently, microcomputer benchmarks only had to operate in a single-user environment," Rick says. This is BYTE's first attempt at multiuser system benchmarks; Rick encourages your feedback.

"I don't think anybody really enjoys writing benchmarks," says Ben. "You are always going to be criticized for them. Manufacturers will claim that they [the benchmarks] don't fairly test their machines. Editors claim they are too complex or not broad enough. But readers appreciate our work, and that is important."—*Michael E. Nadeau*

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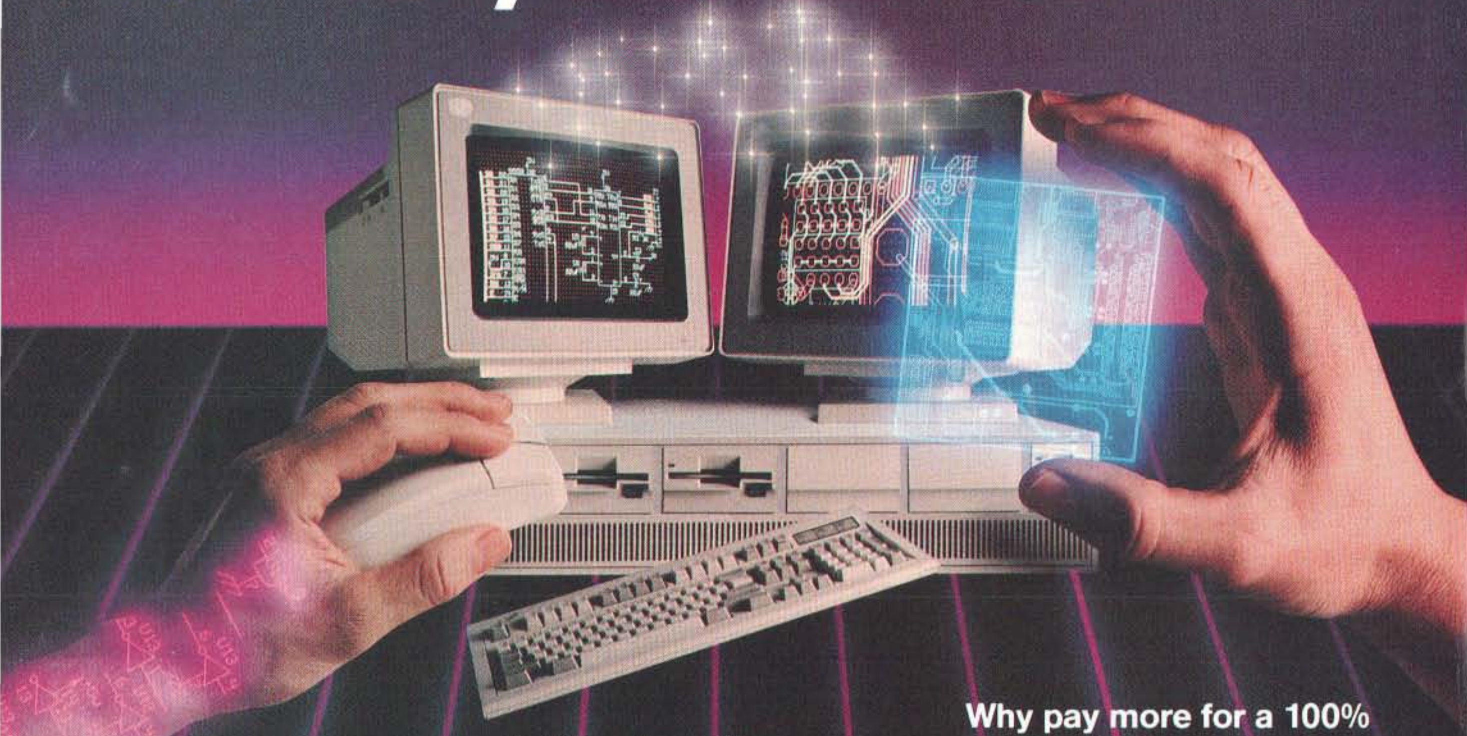

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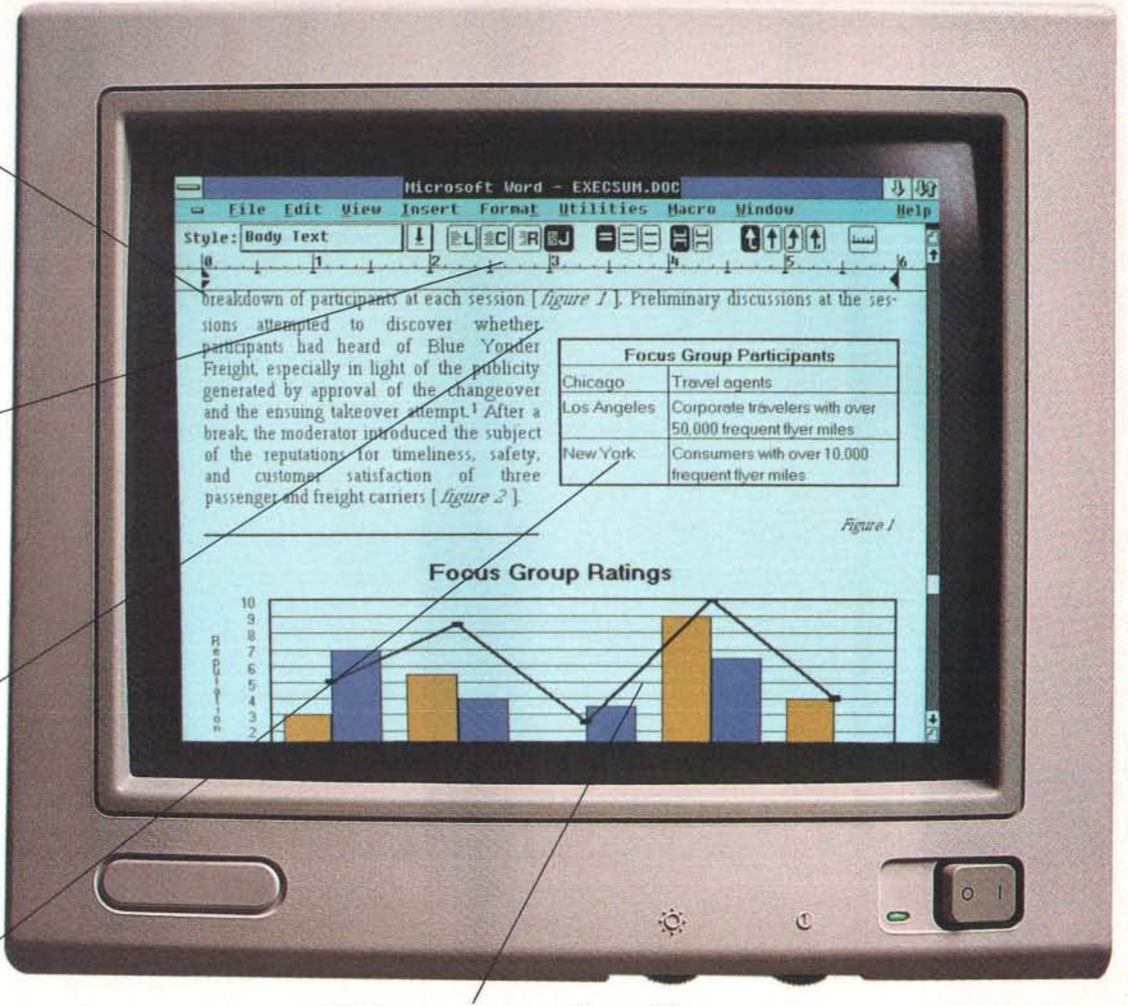

breakdown of participants at each session [*figure 1*]. Preliminary discussions at the sessions attempted to discover whether participants had heard of Blue Yonder Freight, especially in light of the publicity generated by approval of the changeover and the ensuing takeover attempt.[1] After a break, the moderator introduced the subject of the reputations for timeliness, safety, and customer satisfaction of three passenger and freight carriers [*figure 2*].

Focus Group Participants	
Chicago	Travel agents
Los Angeles	Corporate travelers with over 50,000 frequent flyer miles
New York	Consumers with over 10,000 frequent flyer miles

Figure 1

Focus Group Ratings

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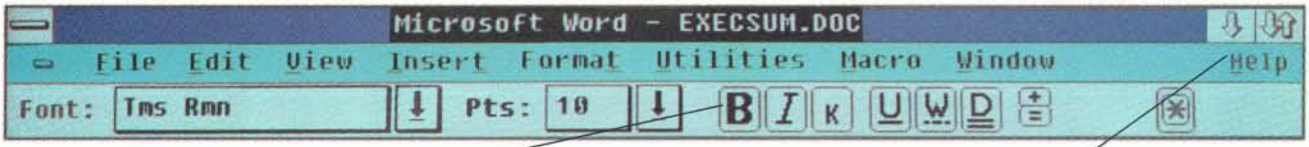
evolve more on these s in the last ten years.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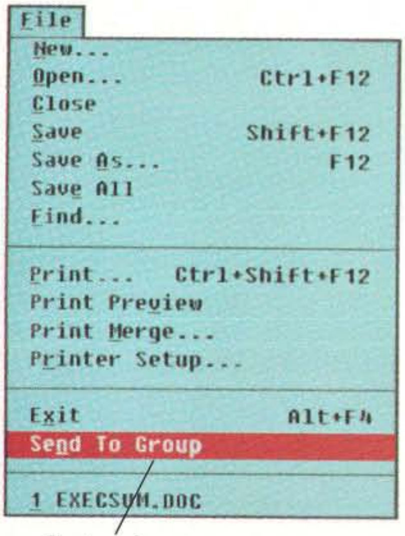

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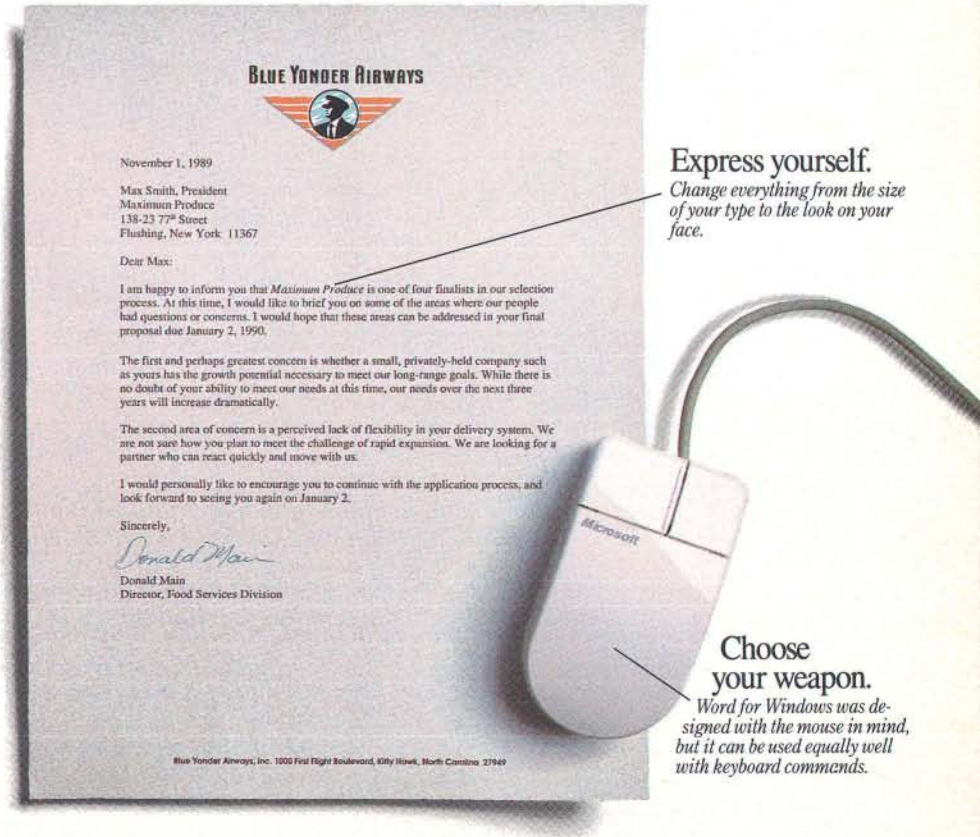

BLUE YONDER AIRWAYS

November 1, 1989

Max Smith, President
Maximum Produce
138-23 77th Street
Flushing, New York 11367

Dear Max:

I am happy to inform you that *Maximum Produce* is one of four finalists in our selection process. At this time, I would like to brief you on some of the areas where our people had questions or concerns. I would hope that these areas can be addressed in your final proposal due January 2, 1990.

The first and perhaps greatest concern is whether a small, privately-held company such as yours has the growth potential necessary to meet our long-range goals. While there is no doubt of your ability to meet our needs at this time, our needs over the next three years will increase dramatically.

The second area of concern is a perceived lack of flexibility in your delivery system. We are not sure how you plan to meet the challenge of rapid expansion. We are looking for a partner who can react quickly and move with us.

I would personally like to encourage you to continue with the application process, and look forward to seeing you again on January 2.

Sincerely,

Donald Main

Donald Main
Director, Food Services Division

Blue Yonder Airways, Inc. 1000 First Flight Boulevard, Kitty Hawk, North Carolina 27949

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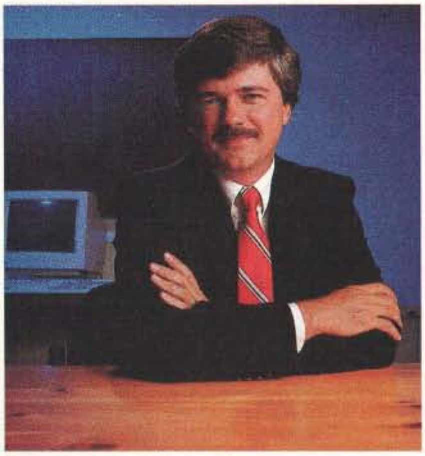

EDITORIAL ■ Fred Langa

STYLE AND SUBSTANCE

A few changes in BYTE, and a curious tidbit in the Xerox vs. Apple lawsuit

Here's a common problem: You find a new software package that looks like just what you need. Then you open up the package and find that the documentation (if there is any) consists of a couple of folded sheets, an errata list, and a rabbit's foot. The "simple installation procedure" requires a Ph.D. in computer science, and the user interface could make strong men cry. The most frustrating part of this scenario is that the package may indeed be just what you need, if you could only figure out how to use it!

At BYTE, we are well aware that magazines can fall into the same trap as software publishers. BYTE has always provided the most in-depth technical information available among computer magazines. In the last few years, we've worked hard to make that information more readable and more practical. We've brought some of the top writers in the industry on-board to help us bring you substantive information in a clear, accessible style.

We've also made periodic adjustments to our "user interface"—the parts of the magazine that help you get *at* all that information. Five times a year, we ask a large number of randomly selected BYTE subscribers what they think of BYTE. We also get mail—boy, do we get mail—every day, from readers who take their own time to write to us. That all adds up to an impressive amount of suggestions, advice, and thoughtful observations that lets us know how we can make BYTE serve you better. Here are a few changes that we're instituting with this issue.

Spotlight

First, we've added a new Spotlight section on page 6, to help call your attention to unusual or especially noteworthy items in each issue's editorial lineup. For example, this month's Spotlight focuses on our new Unix benchmarks and lets you meet the folks who wrote them.

News

We've renamed our opening section News, which starts off with BYTE's award-winning Microbytes section. This is followed by our new product department, What's New, which has been given a modest face-lift.

Beta Hardware and Software

A bit further into the magazine, you'll now find all articles dealing with beta software and preproduction hardware grouped together.

On page 114, our redesigned Short Takes section brings you succinct summaries of the most interesting soon-to-be-released hardware and software we've learned of. Immediately after Short Takes, you'll find First Impressions on page 122 (this month's issue has only one); these are longer, more in-depth looks at especially significant forthcoming products. Naturally, the number of First Impressions each month varies with the level of innovation in the microcomputer industry.

New Columns

Two new columns have drawn so much attention that we're giving them their own section: Perspectives will contain our popular opinion column Stop Bit and Hugh Kenner's Print Queue column. Stop Bit and Print Queue will be joined by the ever-popular question-and-answer portion of Jerry Pournelle's Computing at Chaos Manor column, Chaos Manor Mail.

Please take a look at these changes, and tell me what you think. Your opinion matters, and it will help us make BYTE exactly what you need in a computer magazine.

Xerox vs. Apple

The lawsuit that Xerox has filed against Apple, alleging that Apple had misappropriated Xerox technology in producing the Macintosh, sent some readers into their back issues of BYTE.

Back in February 1983, BYTE published an interview with three key members of the Apple Lisa design team: Wayne Rosing (technical manager of the entire Lisa project), Bruce Daniels (Lisa systems software), and Larry Tesler (Lisa applications software). The Lisa, of course, was the precursor to the Macintosh.

The interview goes on for many pages, revealing a number of interesting and little-known facts, including this tidbit:

BYTE: Do you have a Xerox Star here that you work with?

Tesler: No, we didn't have one here. We went to the NCC when the Star was announced and looked at it. And in fact it did have an immediate impact. A few months after looking at it we made some changes to our user interface based on ideas that we got from it. For example, the desktop manager we had before was completely different; it didn't use icons at all, and we never liked it very much. We decided to change ours to the icon base. . . .

If you're interested in the legal roots of one of today's thorniest computer-related lawsuits, there's lots more in the interview; it begins on page 90 of that issue. There's also substantial current discussion on BIX, especially in the "applecase" topic of Jerry Pournelle's tojerry conference. (My thanks to "kkubik" on BIX, who brought this to my attention.) It's worth checking out.

—Fred Langa
Editor in Chief
(BIX name "flanga")

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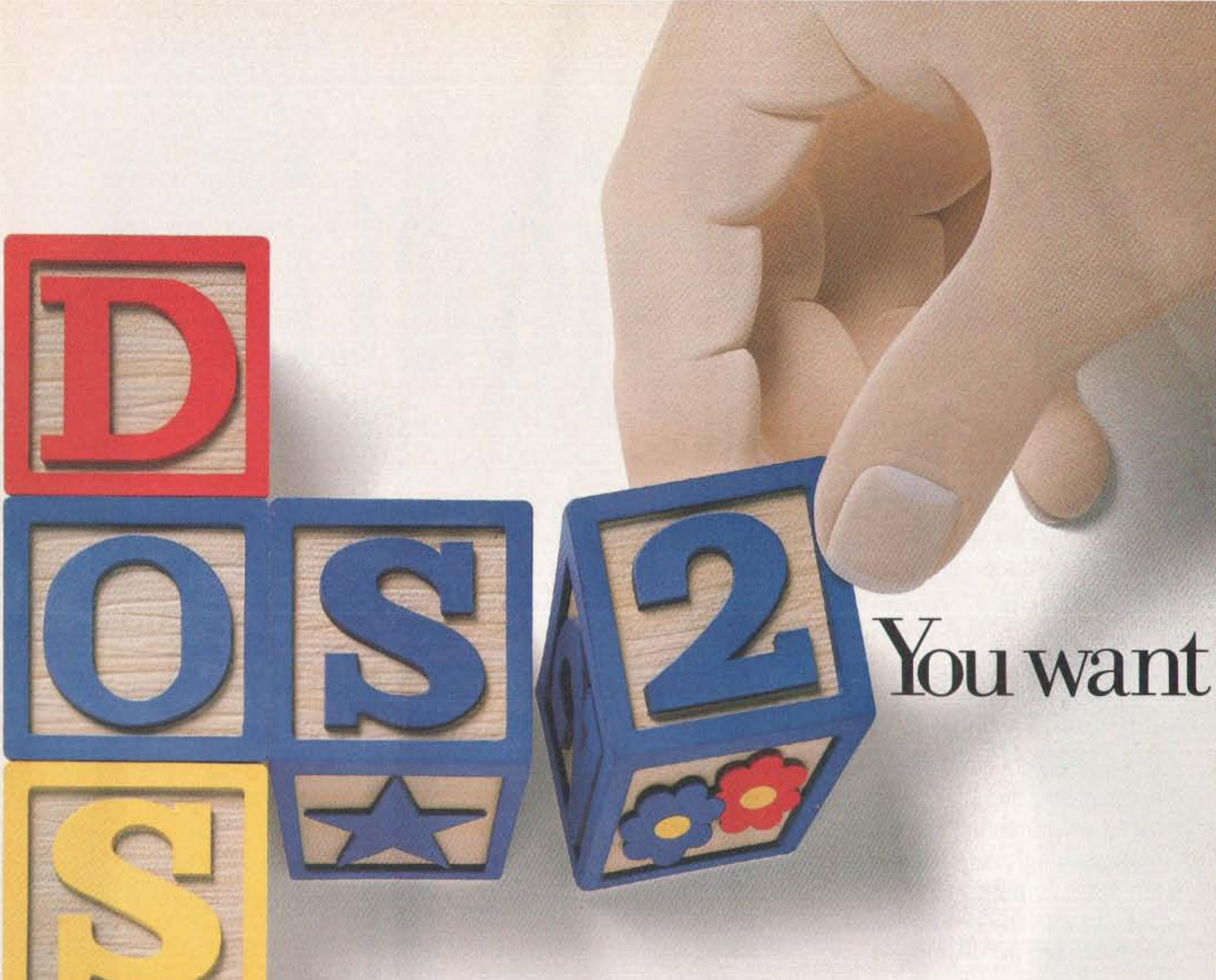
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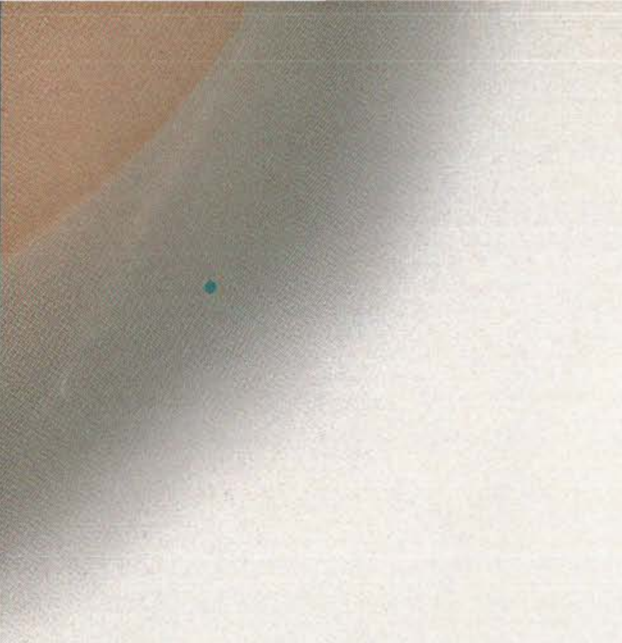

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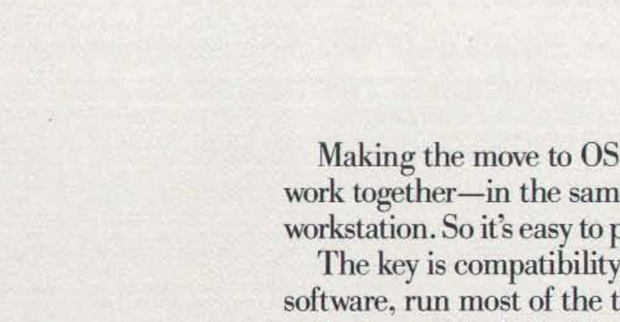

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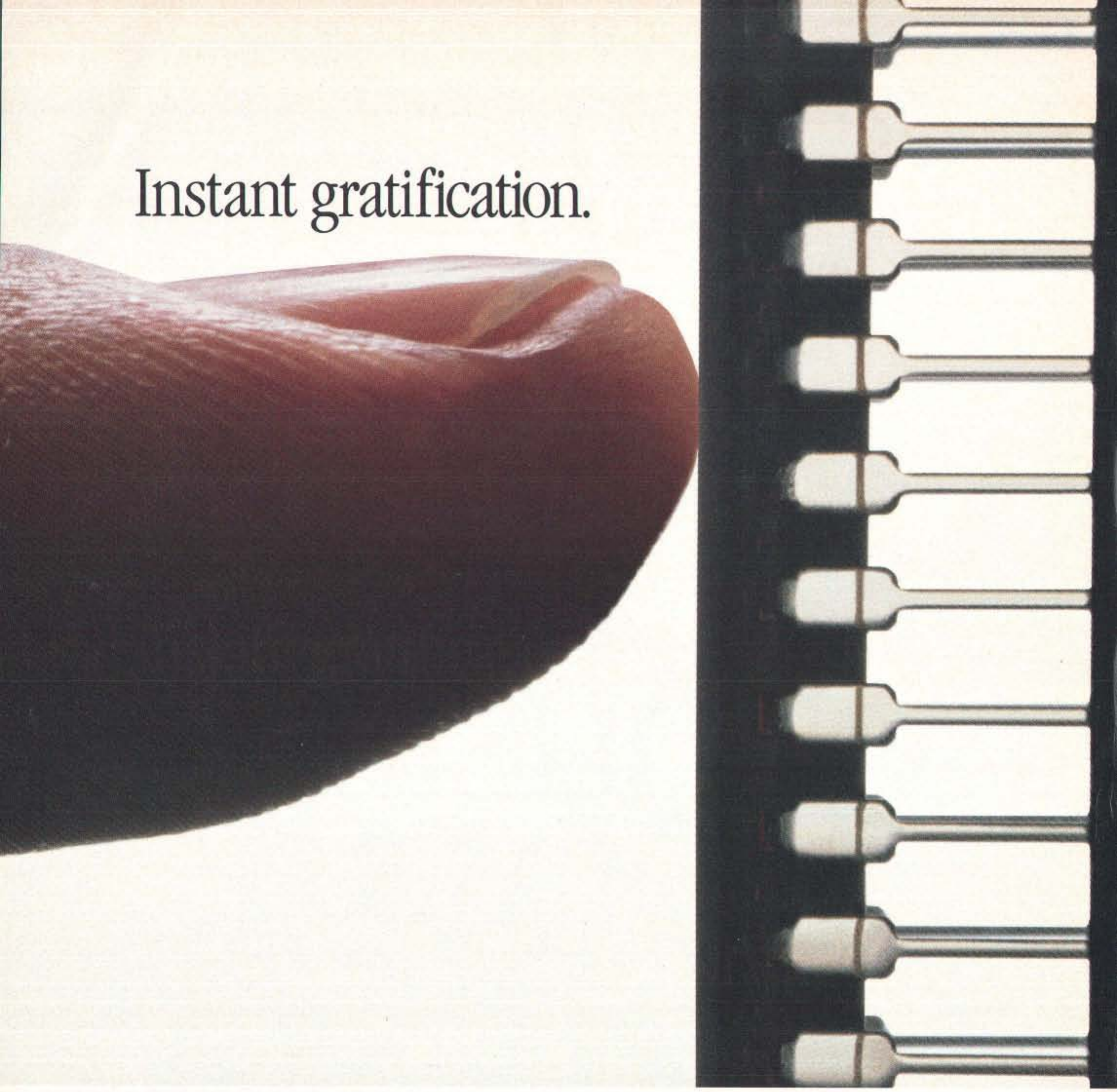

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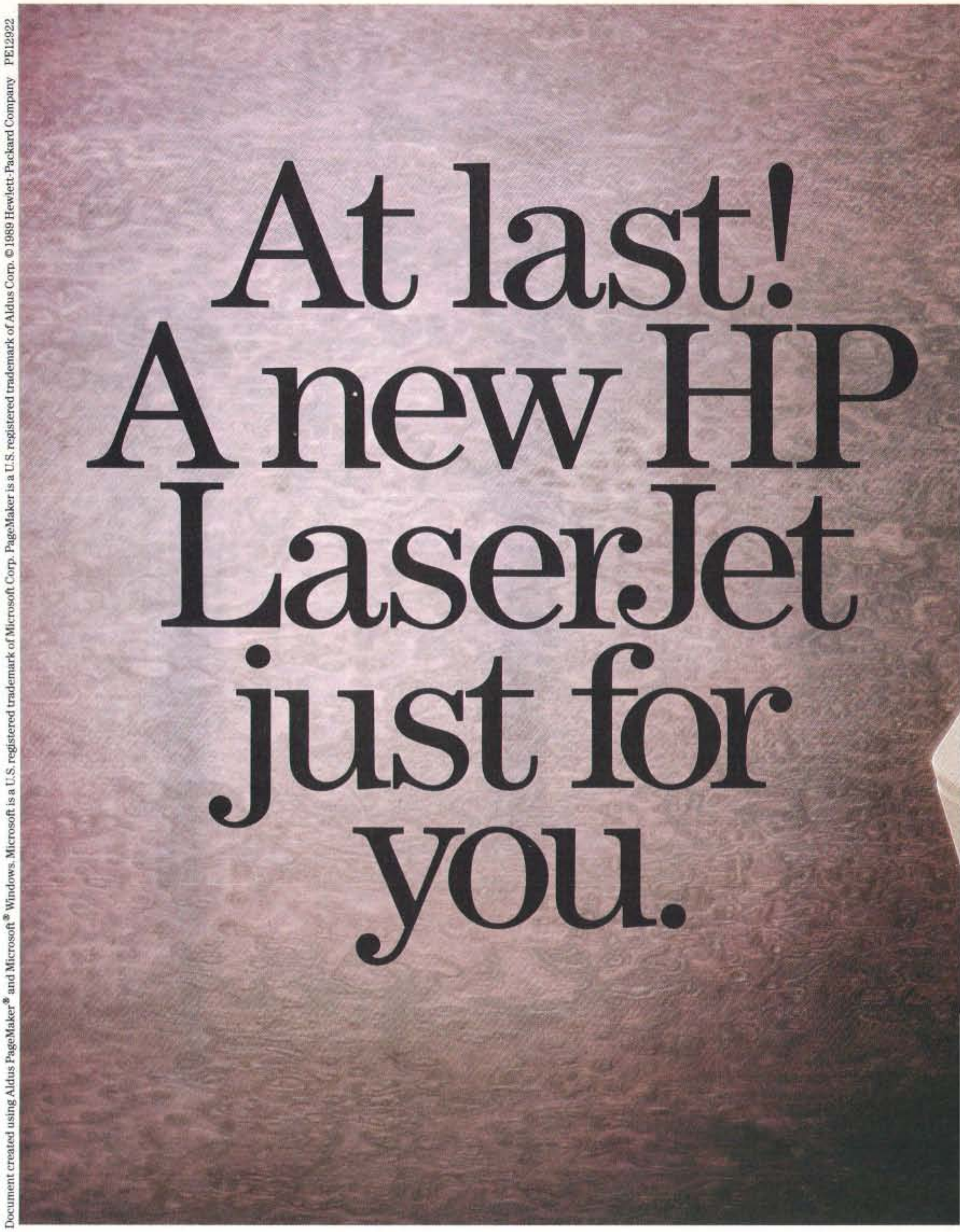

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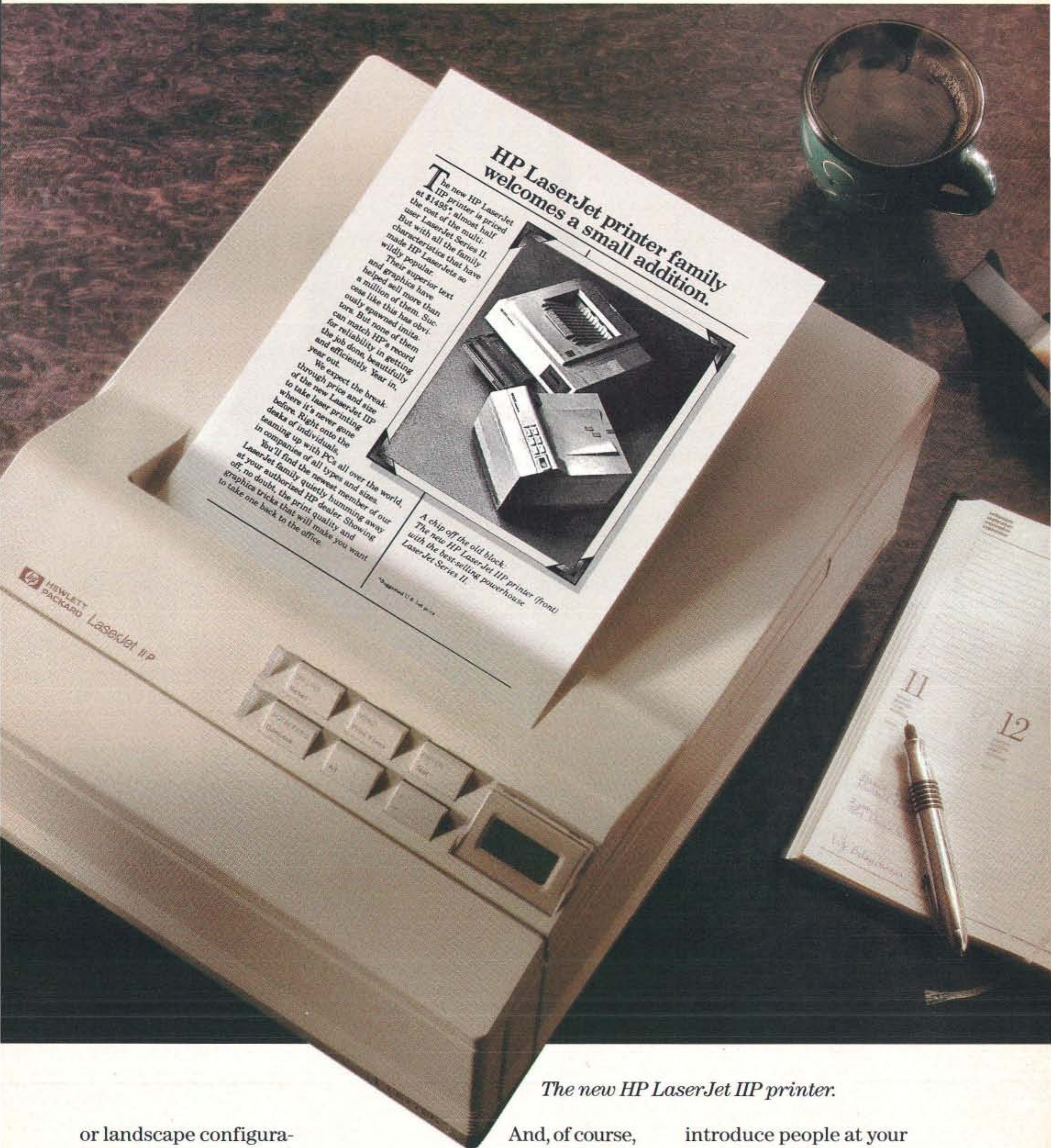

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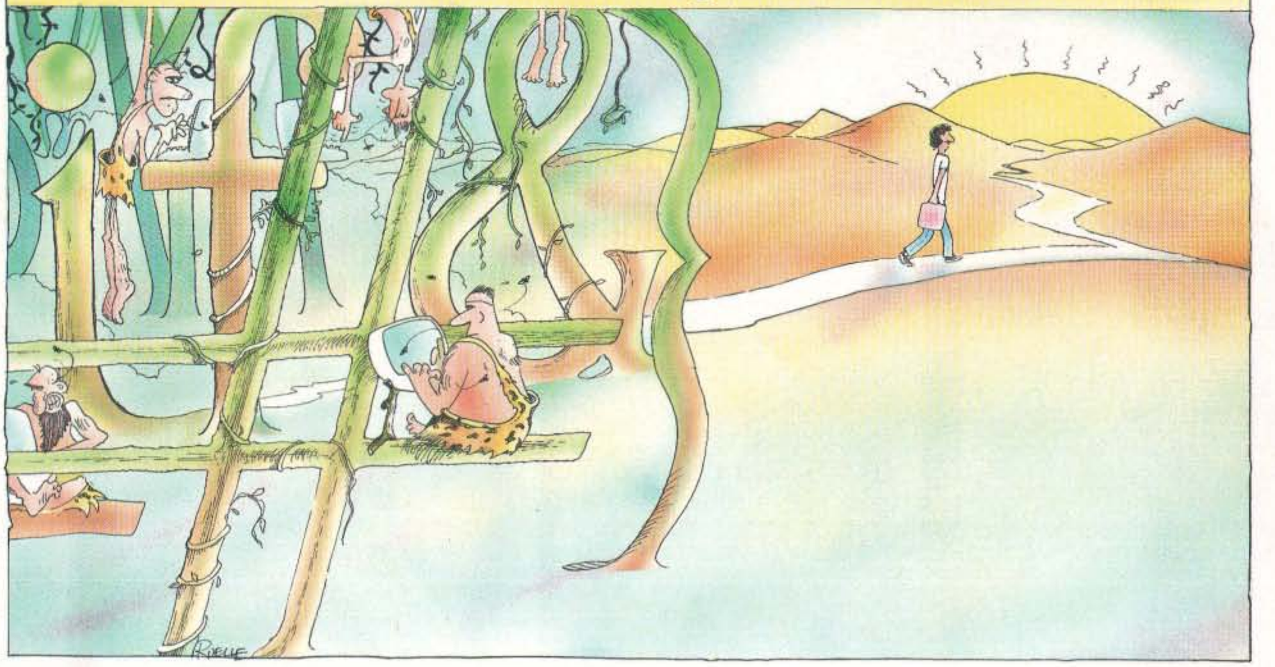

Code-dweller emerges from the jungle

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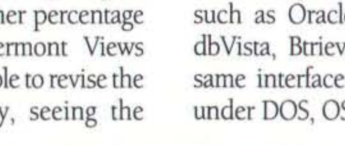

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MICROBYTES

Staff-written highlights of developments in technology and the microcomputer industry, compiled from Microbytes Daily and BYTEWEEK *reports*

Multimillion-Transistor Chip Can Repair Itself

Engineers from TRW and Motorola, working together under contract for the Department of Defense, say that they've succeeded in putting more transistors on a chip than ever managed before. The new Central Processing Unit–Arithmetic Extended SuperChip holds about 4 million 0.5-micron CMOS devices and is capable of performing 200 million floating-point operations per second, according to Motorola. This amount of processors would put the single 1½-ounce chip on the same processing level as supercomputers.

One problem with a chip of this size and density is a tendency toward high failure rates. But the developers have equipped the SuperChip with a way of "repairing" itself if any of its parts fail.

The SuperChip is used with a "satellite" chip, the TRW-Motorola Universal Processor (UP), which configures the SuperChip initially, tests it, and monitors it during operation. The SuperChip's ability to repair itself is due to its modular nature. The SuperChip architecture consists of "macrocells" that are essentially processor building blocks. The chip holds 142 of these, of which only 61 are required for the SuperChip to be fully functional. The UP tests the SuperChip initially and marks those macrocells that do not work. It then configures the SuperChip to use a working combination of 61 macrocells and marks the rest of the functioning macrocells for later use if any part of the chip should fail. If any macrocells do fail, then the UP can reconfigure the SuperChip to use one of these spare macrocells.

Each of the macrocells represents a standard processor function and operates as an independent device. The macrocells range in size from 10,000 to 100,000 logic devices. The SuperChip uses the following macrocells: address generator, microcontrol unit, multiplier/accumulator, UP, read memory interface, write memory interface, column disable block unit, ALU, storage element, and one-port RAM unit. One or more of each of these is required to build a functioning SuperChip.

The SuperChip is intended to be used as the central processor for advanced digital signal processing systems, particularly in military systems, where the self-repairing design would be useful. However, Motorola and TRW also envisage future versions of the chip being used in commercial applications, particularly in complex imaging, medical diagnosis, and CAD.

The longer-term implications are also very interesting. Usually producing such complex chips at the limits of current technology is an expensive business because of the high failure rates of chips using these methods. The SuperChip architecture, however, allows for manufacturing flaws in the production of the SuperChip without affecting its ability to function. This results in a higher and more commercially viable manufacturing success rate. The technique could allow chip makers to produce more powerful processors much faster than they otherwise might. Perhaps Intel's 80786 CPU will be ready by the year 2000 after all.

—Owen Linderholm

Network Shell "Masks Differences"

VXM Technologies (Boston) has come up with a novel approach to the problems of distributed computing over a network of heterogeneous (and sometimes mutually hostile) systems. The VXM Network Shell essentially takes the concept of the Unix shell commonly used in that environment and extends it to control a network.

According to VXM president Franco Vitaliano, the VXM shell "essentially masks differences between machines and operating

continued

NANOBYTES

Thinking Machines (Cambridge, MA) is aiming for a speed record of **1 trillion operations per second** with a future model of its parallel-processing Connection Machine. The current million-dollar machine uses 32,000 processors to zip through 8 billion floating-point operations per second, according to company figures. Thinking Machines, working under a Defense Advanced Research Projects Agency contract, plans to have the components of its new system working in 1992; there's no official word on when the Mega machine itself will be ready. The biggest river to cross, according to chief scientist Danny Hillis, is incorporating fault tolerance into the massively parallel machine.

Only a memory: After eight months of trying to garner investors and support, **U.S. Memories,** the proposed cooperative venture for making DRAM chips in the U.S., called it quits. Formed last June, the company had the backing of heavyweights like IBM, Digital Equipment, Hewlett-Packard, and Intel, but other computer makers, like Apple and Sun, refused to get involved, saying that their supplies of memory chips are adequate. The initial investors figured that they would need $1 billion to make the proposal work. Some industry watchers lamented the demise of U.S. Memories, charging domestic computer companies with too much attention to short-term profits and too little memory of last year's shortage of DRAM chips.

More than one-half of the state departments of transportation are using **CAD systems** and are now requiring contractors to do the same, according to Design Systems Strategies (Scarborough, ME). The state agencies are using more Intergraph workstations than any other type of system, DSS says in a recent report.

NANOBYTES

Meanwhile, in Japan, the Japan Personal Computer Software Association (Tokyo) will start next month conducting **certification exams for CAD operators.** The organization hopes to increase the number of CAD users in the country, as well as boost their knowledge of the subject. Government agencies back the program.

IBM has developed a new hardware/software combo that **lets hearing-impaired people send voice messages from a PC** to someone using an ordinary push-button telephone, who can then reply using the telephone's keypad. The new $600 Phone-Communicator, which works with the IBM PC or PS/2 Models 25 and 30, consists of a multifunction board with a modem and a speech synthesizer and software for writing and reading messages. The hearing-impaired user types a message on the computer keyboard, and the synthesizer speaks it over the telephone; the hearing user types a response using the letters on the telephone keypad, and the system translates tones and sends them to the computer screen. For information, contact the IBM National Center for Persons with Disabilities, P.O. Box 2150, Atlanta, GA 30055, (800) 426-3388 (voice) or (800) 426-2133 (TDD).

Borland International has sold off another of its Turbo packages. This time it's **Turbo Prolog,** which now is in the hands of its creator, the **Prolog Development Center,** based in Denmark and Atlanta. PDC will develop, market, and support future versions of the Prolog compiler, including a new OS/2 version (slated to be out last month) and one for The Santa Cruz Operation's Unix, scheduled for later this year. PDC says it has improved the current DOS edition by adding more than 40 new predicates and a better interactive development environment. The biggest difference is that PDC has rewritten Turbo Prolog to be more modular, making it easier to bring out versions for other operating systems.

systems." In each computer on a network, a small (128K-byte) VXM program written in ANSI C interprets ASCII scripts written in the VXM programming language. Vitaliano says that only about 10 percent of the VXM shell has to be customized for the operating system that it's running under. Each machine on the network "sees" the VXM shell as just another running application.

The result, according to Vitaliano, is that the VXM shell provides a way to develop software on one machine (e.g., a PC running DOS) and distribute the script across the network to run on any other system (e.g., a Sun workstation running Unix). Unlike applications developed in a portable language such as ANSI C, programs developed using the VXM language don't need to be modified and recompiled to run under a different operating system because they're plain-vanilla ASCII.

Currently, the VXM system, which Vitaliano calls a "SoftRobot," runs only on Novell and TCP/IP networks. But he expects the company to migrate the VXM system to OSI and proprietary networks in the near future. Whichever network it runs on, programmers won't need to learn any technical details of the network to develop distributed applications, VXM claims; the VXM shell insulates them from network and operating-system particulars.

In a heterogeneous system, VXM says, the VXM system can automatically perform a complex series of actions, translate commands between unlike systems, start other tasks, supervise systems, run software, use communications and I/O facilities, read and write files, use file systems and databases, leave messages, unify different E-mail systems, operate equipment, and interact with users.

The VXM Network Programming language is similar to Lisp, although it uses C syntax. However, it's designed and optimized for operation on ASCII character strings. It consists of 85 primitives. VXM scripts can execute VXM programs simultaneously at several nodes across the network. Vitaliano says that one of VXM's most powerful features is its macro-generation capabilities. Previously defined scripts can call other scripts.

VXM Network Shell costs $895 for DOS-based systems ($295 for each additional node), $2495 for Unix workstations, and $2995 and up for VAX systems. The company expects to have a shell for the Macintosh soon.

—Stan Miastkowski

Microprocessors Are Bringing Down the High Cost of Supercomputing

Supercomputing no longer means liquid-nitrogen coolant and millions of dollars. New systems that use large arrays of microprocessors are providing computing capability comparable to that of some supercomputers at a significantly lower price.

The new iPSC/860 from Intel Scientific Computers (Beaverton, OR) is a parallel-processing system based on Intel's i860 RISC-like CPU, a high-speed chip with powerful floating-point capabilities. This machine, which starts at $265,000, comes standard with eight i860 processors and can be configured with as many as 128. Intel claims that the top-of-the-line iPSC/860 can perform up to 7.6 billion floating-point operations per second, putting it in the same neighborhood as a Cray Y-MP supercomputer. The system supports as many as 128 I/O controllers, each of which is based on an Intel 80386 processor and can have as much as 2 gigabytes of memory. The iPSC runs a version of Unix optimized for parallel code execution and comes with software for generating parallel-processing applications.

As the cost of the i860 comes down, so will the price of systems using it. Intel's new machine suggests that a commercial Unix-based system with two to four processors could be built not too long from now and priced at $30,000 or less.

MasPar Computer (Sunnyvale, CA) uses a massively parallel architecture in its new family of "minisupercomputers." The MP-1 system can be packed with thousands of processors—from 1024 to 16,384. This approach is similar to that of Thinking Machines, whose million-dollar Connection Machine strings together 32,000 processors. MasPar claims the low-end MP-1101 ($117,000) can crank out 1875 million instructions

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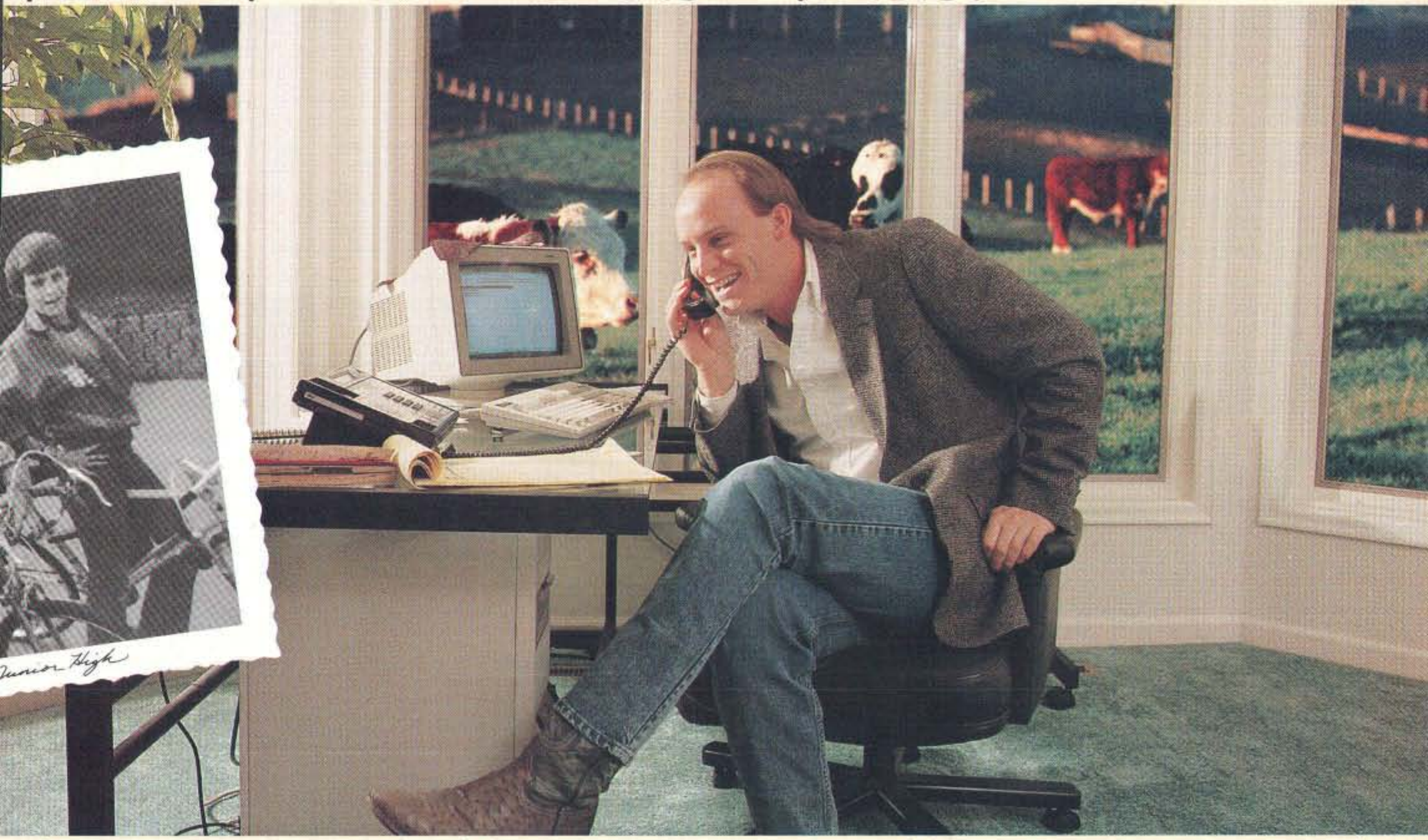

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NANOBYTES

Japanese schools have plenty of computers but few teachers who feel proficient with them, according to a survey by Japan's Ministry of Education. The average senior high school had 25 computers, but only about 13 percent of the teachers thought that they could install and operate them. (The figures were quite a bit lower in the lower grades.) Most of the systems in Japanese schools are 16-bit machines, the survey found. More than half of the computers are set up in the faculty room, indicating that the teachers are trying to learn how to use them.

High Tech Shows (Dallas) plans to go on the air this month with a TV **program about new electronic products and new technologies**. The Electronic Products Network will be a series of 30-minute shows featuring what's new in the consumer electronics market, including computers, software, and telecommunications gear. The producers hope to line up major manufacturers like Toshiba, Panasonic, NEC, Sharp, Fujitsu, and Lotus. High Tech hopes to have the show air in major TV markets, including Dallas, Houston, and Boston. Electronic Data Systems is backing the series.

Apple Computer and **Quickview Systems** have settled a lawsuit over **HyperCard.** The lawsuit claimed that HyperCard infringes on patents that Quickview received for its Zoomracks software. (In Zoomracks, you collect information on racks of "cards"; in HyperCard, you put information on stacks of cards.) The settlement includes a patent cross-licensing agreement that means that HyperCard users can't be charged with infringing on Quickview patents. "As long as you're using or developing for HyperCard on Apple equipment, you're covered," said Apple spokesperson Stacey Byrnes. Quickview founder Paul Heckel said the settlement also covers people using HyperCard clones on Apple computers. But HyperCard-like software running on non-Apple equipment will still be subject to licensing, he said.

per second and 94 million floating-point operations per second and that the high-end MP-1216 ($810,000) can operate at 32,000 MIPS and 1500 MFLOPS. Although these prices are astronomical by microcomputing standards, the performance rating works out to about $30 per MIPS.

The core of the MP-1 is the Processor Element Array; each processor element is a register-based load/store RISC processor designed by MasPar and operating at 1.8 MIPS. MasPar has crammed 32 processors onto a single chip, along with 40 32-bit registers for each processor. The system operates in a single-instruction multiple-data fashion, meaning that each processor in the array performs the same operation simultaneously but on a different item of data. The MP-1 uses Digital Equipment's Ultrix variant of Unix and employs the VAXstation 3520 for communicating with users and with other systems over Ethernet. The I/O subsystem can operate at 230 megabytes per second over a 64-bit channel, MasPar says.

Software is a significant challenge for these new computers. Very few massively parallel systems are available, and most computationally intensive code will have to be rewritten to take advantage of their power. MasPar officials believe that the MP-1's graphical, object-oriented programming environment, which is based on ParcPlace Systems' Objectworks for Smalltalk-80, will make it easier to develop code for parallel systems. Tom Blank, MasPar's vice president of architecture and applications, said that for most applications, the majority of code can be ported directly with minimal changes and that only the computational core of the program will have to be rewritten in parallel form.

The new Intel and MasPar systems are high-ticket items by personal computer standards, but they are commercial proof of the viability of multiprocessing microprocessor-based supercomputers.

—Nick Baran, Owen Linderholm, and Rich Malloy

Printer Generates Tactile Graphics for the Blind

While software that translates text into Braille and printers that punch out Braille characters have been available for years, the National Federation for the Blind says that visually impaired people have been left behind when it comes to computer-generated graphics.

Working with the NFB, Howtek (Hudson, NH) has modified its PixelMaster Color Ink Jet printer to print text in Braille in raised graphics that visually impaired users can easily interpret. The PixelMaster creates images by spraying plastic-based ink onto paper. The red, green, and blue inks dry instantly into raised dots. And according to Howtek vice president Ed Marino, it's the raised nature of the dots that makes tactile communications possible.

The company has made a few changes to the PixelMaster's firmware in order to add an extra layer of ink to the finished print. These alterations brought the ink-jet printer's raised output up to international Braille specifications.

The PixelMaster comes with software (for either DOS or Macintosh computers) that translates ASCII into Braille. Software also outputs on-screen graphical images to the printer, creating a tactile version of the image, which can be annotated with remarks or explanations in Braille.

Tim Cramner, director of technology for the NFB, says the Howtek printer produces "tactile graphics." It's currently the only available product that can handle maps, charts, and other images for blind people. The NFB used the PixelMaster to create floor plans of its exhibit center at last July's national convention in Denver.

At Oregon State University, physics professor John Gardner is using the PixelMaster to generate charts and graphs produced by his graduate students. Previously unable to see his students' printed output, Gardner says the tactile graphics literally add a new dimension to his ability to interact with them.

With a price of $6995 (including software), the PixelMaster obviously isn't designed for individuals. Howtek's Marino says that besides educational institutions, many major corporations have purchased the PixelMaster. New England Telephone uses it to keep its visually impaired employees more informed, allowing

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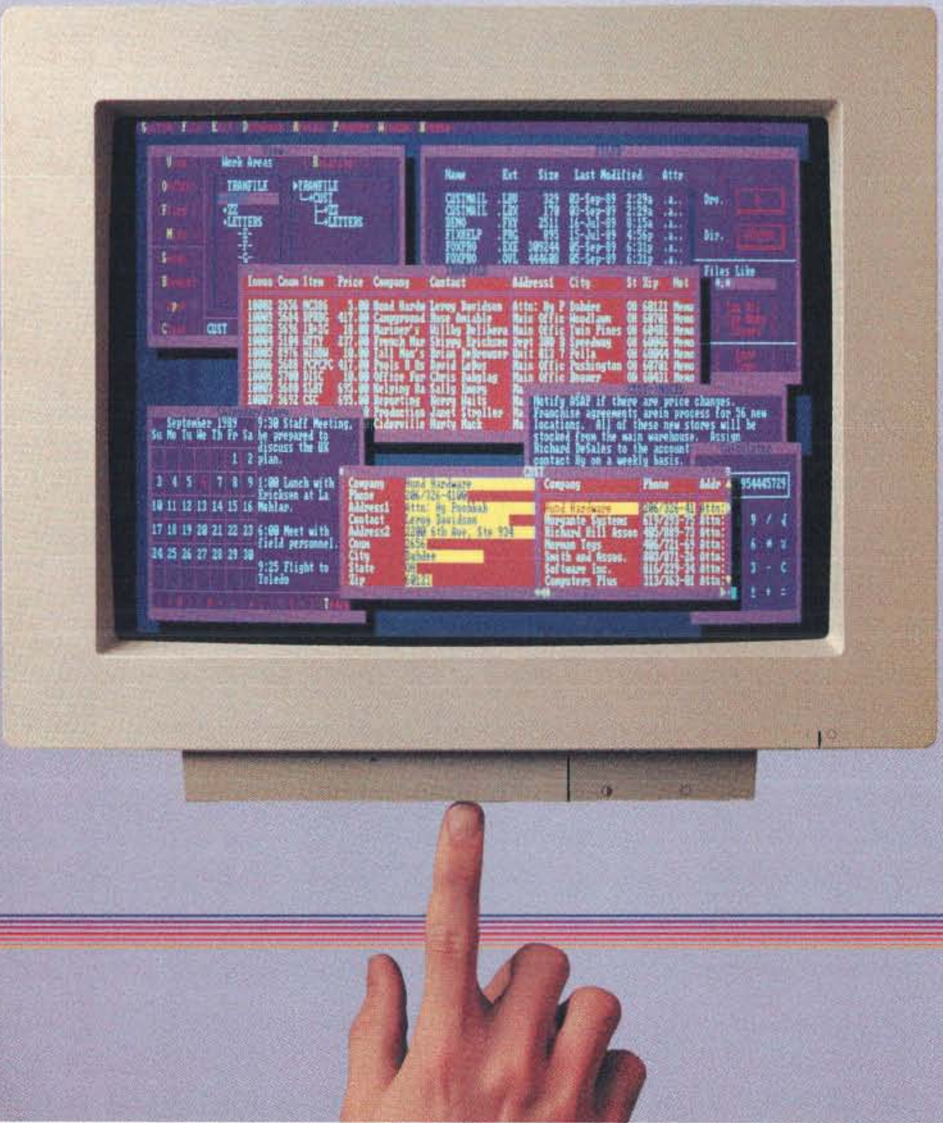

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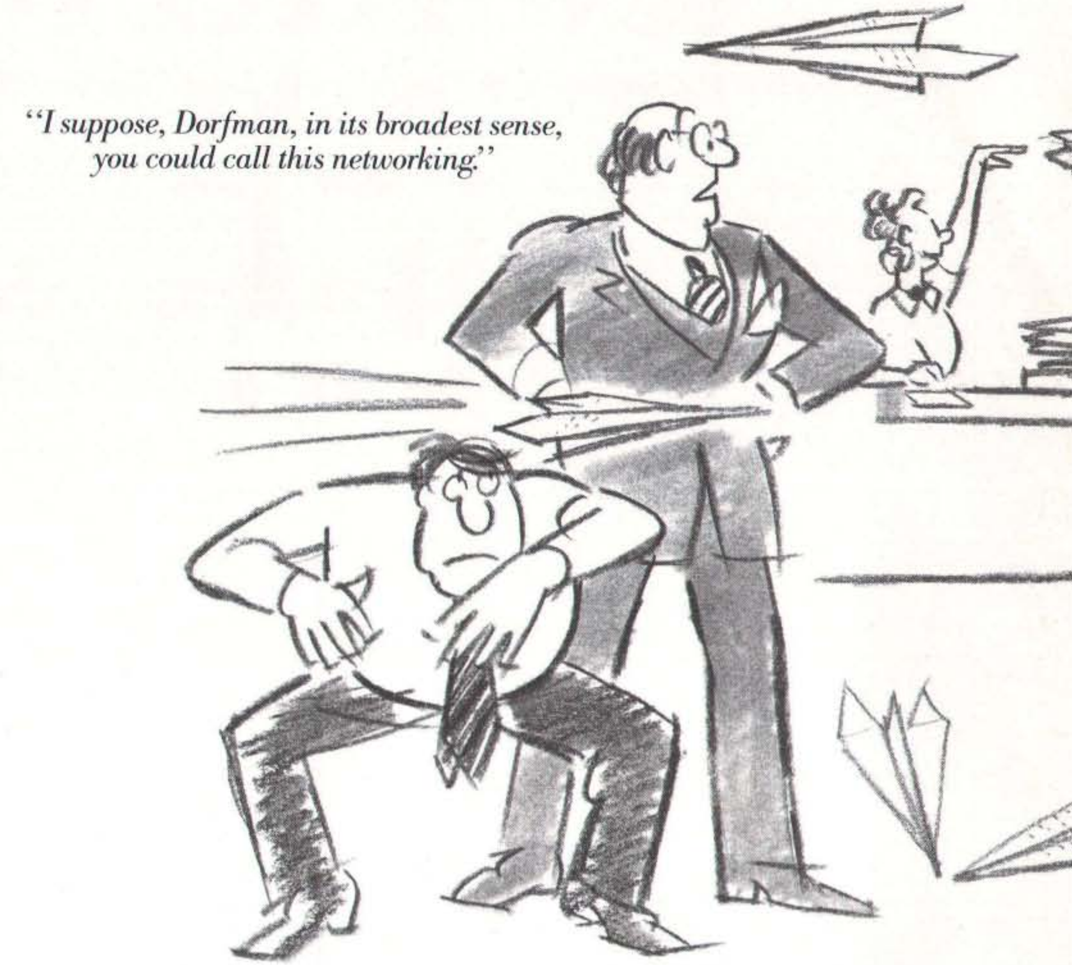

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them to interpret the graphic as well as the textual information contained in memos. According to an NET spokesperson, before tactile graphics, it was "virtually impossible for a visually impaired person to interpret a simple flowchart."

Marino says that Howtek plans to make the Braille and tactile graphics capabilities standard in future versions of the PixelMaster.

—Stan Miastkowski

NANOBYTES

"Rumors of the **death of the minicomputer** are greatly exaggerated, to paraphrase Mark Twain," said Hewlett-Packard CEO John Young as the company rolled out 24 new minicomputers and network servers. Some of the new systems will implement HP's new 0.8-micron RISC processor.

In Tokyo, **Toshiba** has improved the **usability of gates** in one of its lines of CMOS gate arrays by 20 percent, as well as increasing the packing density of the chips. The new 1-micron TC150G series can have as many as 100,000 usable gates, Toshiba says, which means that designers should be able to build larger and more powerful systems on a chip.

A new device from **Laser Communications,** Inc. (Lancaster, PA), uses infrared **laser beams to connect Token Rings** in separate buildings into a single LAN. The rooftop transceiver units can transmit data as far as a kilometer (⅗ mile) across unobstructed space at 4 megabits per second, LCI says. The system is compatible with IEEE 802.5 and IBM Token Ring specifications. Although the Lace Token Ring System eliminates wiring hassles, the units have to be carefully aligned and calibrated and could be useless on a foggy day. Like the company's earlier similar system for Ethernet LANs, the Token Ring setup is expensive: It starts at $26,649.

If the **stock market** gets bearish, computer software and service stocks will suffer, says **Drexel Burnham Lambert** (New York) in a new report. "These stocks as a group tend to be one of the first groups impacted when investor sentiment turns negative, and to lag the market on the upside when sentiment turns positive," according to one analyst who worked on the report. The fortunes of companies selling packaged personal computer software, however, will be affected more by sales of computer systems than by market whims, the analyst notes. One company getting a "buy" recommendation: Ashton-Tate.

Gigabit Data Density Promises Big Gains in Capacity of Magnetic Disks

Using prototype components and new recording-head technology, IBM scientists have squeezed 1 gigabit of data into 1 square inch of disk surface, claiming a world record for magnetic storage density. (On a typical hard disk today, data is stored at approximately 35 to 45 megabits per square inch.) Scientists at IBM's Almaden Research Center (San Jose, CA) say that their success at storing 1 billion bits in a small area of disk surface promises computer users a decade of steady gains in the capacity of magnetic storage devices. "Magnetic storage will be able to evolve in such a way to allow significantly more information to be stored on a magnetic disk," said IBM spokesperson Michael Ross. Computer users can expect to see disk capacity increase by as much as 30 times, he said.

The 5¼-inch aluminum disk used in the experimental system is coated with a magnetic cobalt alloy designed for higher bit density and lower magnetic noise than current disks. Bits were stored at a linear density of 158,000 bits per inch, IBM said. During the successful test, data was written and read at a rate of 3½ million bytes per second, according to the IBM scientists.

IBM researchers had to develop a new recording head to reliably read the ultra-small bit cells on the disk. What they came up with was a head that uses an inductive write element and a magneto-resistive read element. The experimental thin-film recording head flies just 0.000002 of an inch over the disk; current heads hover at about 0.000006 to 0.000015 of an inch above the platter, an IBM spokesperson said. This new head can detect bits too small for all-inductive recording heads to find.

Although the components used to achieve this level of storage density are experimental, IBM said that none of them, including the recording head, involves developing new manufacturing techniques.

It will be later in the 1990s before commercial products incorporate this gigabit technology. "Significant work is required to ensure that the components used in this demonstration could be reproducibly manufactured in volume and that storage devices with adequate reliability can be made at such low flying heights," said Barry Schechtman, manager of storage systems and technology at the Almaden Research Center.

—D. Barker

Group Seeking Common Fax Connection

At about the time you're reading this, members of the Telecommunication Industry Association (TIA), which is based in Washington, DC, will be voting on a proposal that could help standardize computer-based fax communications.

The TR-29.2 standard is being proposed by a technical subcommittee composed of leading hardware, software, and chip companies. The group's aim is to do away with the patchwork quilt approach of proprietary and often-conflicting hardware and software standards that plague the computer fax marketplace.

Currently, it's impossible to send a fax through a fax modem using standard communications software such as Procomm or Crosstalk. But TR-29.2 hopes to change that with extensions to the Hayes AT command set that has become the industry standard for PC data communications.

The proposal initially defines several classes of service. The basic extension of the AT command set will allow for the easy development of general-purpose software designed for

continued

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We are also pleased to introduce new releases of two MicroWay classics — MatrixPak and 87FFT. These products, along with 387Basic, make it possible to generate real mode code with a numerics efficiency that approaches 100%, without resorting to global optimization or assembly language. ***These products are important because most programmers are still using real mode tools in their 386 systems, despite the advantages of the 386's 32 bit architecture.*** The tools solve problems with the Intel real mode segmented architecture which hinders the performance of numerics coprocessors. They employ algorithms that cannot be easily implemented by general purpose compilers.

For example, if you compare programs that multiply matrices, you will discover that the huge model code produced by an excellent product, such as Microsoft FORTRAN, runs 2 to 4 times slower than the MatrixPak matrix multiply. MatrixPak employs a unique storage algorithm in conjunction with runtime binding to produce its results. The same technique is employed by 87FFT, which also employs an "in core" solver that makes it possible to perform FFTs on arrays stored on disk.

387Basic is another MicroWay classic. PC Magazine's November, 1989 review of the current BASICs says,

"387BASIC is the product to use if you have a program which is numeric intensive...the programs ran faster than any of the other BASICs and generated more accurate results."

Naturally, we still sell our NDP Fortran, C, and Pascal 386 compilers and the coprocessors you need to make them perform. PC users have been relying on MicroWay for 8 years to solve their numerics problems. If you have a question about which coprocessor is best suited to your application, call or write for our brochure, "The State of PC Numerics in 1990" by Stephen S. Fried.

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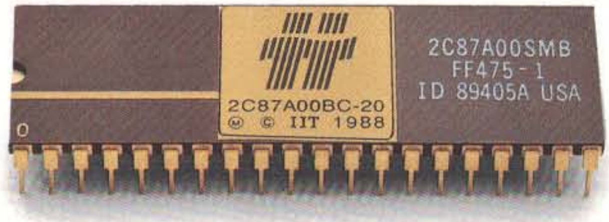

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NANOBYTES

Developers of embedded control applications using the MIPS Computer line of RISC processors (R3000 CPU and R3001 embedded processors) can now do their work on a **Mac II,** thanks to a new add-in NuBus board and software from **Integrated Device Technology** (Santa Clara, CA). The MacStation Development System ($6900) allows engineers to prototype applications on the Mac under Unix. The software supports MultiFinder, so you can test applications in the background.

This spring, Hitachi, Fujitsu, and Mitsubishi Electric plan to start sampling the **32-bit TRON chip,** an important component of Japan's TRON computer architecture/grand scheme. The new Gmicro/3000, developed primarily by Fujitsu, will have an internal memory management unit, a 2K-byte instruction cache, and a 2K-byte data cache. The 25-MHz chip will include about 900,000 transistors.

The National Institute of Standards and Technology is compiling a bibliography related to **computer security** and wants to see glossaries of relevant terms. If you have such a book of definitions, or just the name of such a book, contact Samuel McCrea, NIST, A216 Technology Building, Gaithersburg, MD 20899, (301) 975-5237.

It's hard to imagine Merle Haggard singing about a **trucker and his wireless network,** but thousands of those 18-wheelers will be communicating with central computers from between the white lines within the next few years, a new study says. Waters Information Services (Binghamton, NY) projects that by 1995, more than 100,000 vehicles operated by big trucking firms will be transmitting data back to company facilities using **mobile computing equipment,** including cellular and wide-area radio networks. The report ("Fleet Management for the 90s: Opportunities for Mobile Computing in the Trucking Industry") doesn't predict whether truckers will still have handles like Fuzzy Bear and Road Stud.

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both data and fax communication.

Class 1 service defines a very minimal (primarily serial) hardware interface between the computer and the modem; the CPU would handle all image processing, data conversion, and fax protocol operations. It's designed to provide the special modem transmission methods used for fax (CCITT V.21, V.27, and V.29), along with some basic operations used for fax-to-fax communications. Class 2 fax modems will add built-in control over the actual fax protocols, including options such as extended buffering and document-handling features.

If TR-29.2 is adopted, products integrating Class 1 and Class 2 should become available in the near future. But for the longer term, TR-29.2 also defines a sophisticated Class 3 level that should eventually result in modems that internally handle the actual processing and conversion of fax images. All would be controlled by new variations of those familiar AT commands.

Although a TIA member says that it's nearly a foregone conclusion that the standard will be voted in, the longer-term question is whether or not the standard will become truly accepted. One factor that could help the standard become real is that the committee members represent a wide range of interests. They include makers of fax boards, stand-alone fax machines (those companies want a standard computer interface), ICs, and communications software. Standard-setter Hayes is on the committee, as are AT&T, Intel, Rockwell, and Xerox.

Meanwhile, prices for fax boards continue to fall. Intel recently reduced the price of its Connection CoProcessor from $995 to $695.

—Stan Miastkowski

Breakthrough Lithium Battery Lighter, Safer

Despite big improvements in power management techniques, neither users nor manufacturers of portable computers are happy with current battery options. Recent developments, however, indicate that better batteries could be on the road sooner than expected.

Rechargeable lithium batteries would be ideal for portables, according to George Morrow and other computer designers. But such batteries aren't practical today because of their potential to explode; the only commercial lithium cells now are nonrechargeable "coin" batteries used in cameras, watches, and calculators.

But recently scientists at the University of California's Lawrence Berkeley Laboratory (Berkeley, CA) announced that they have developed a new type of lithium battery that is based entirely on solid materials. Unlike lithium batteries with an aqueous or liquid electrolyte, the new batteries cannot leak or explode when exposed to heat, the researchers say. They should also deliver higher power, additional recharge cycles, and a longer shelf life—all at lower cost—than any commercial batteries now available or known to be under development, the scientists claim. The battery's cathode is made of a new material (consisting of disulfide polymers) that's much lighter than the metal cathodes in contemporary batteries. The new cathode also suggests the possibility of very slim batteries, in which the terminals and electrolyte would be thin films laid on top of each other.

The Berkeley scientists say that the batteries can be recharged 100 times with virtually no loss of energy and that they have demonstrated as many as 350 "deep cycles" in tests. The raw materials are expected to cost less than those of current batteries, which would make replacement practical. Disposal problems would also be minimized because the batteries contain no toxic materials.

—Andrew Reinhardt

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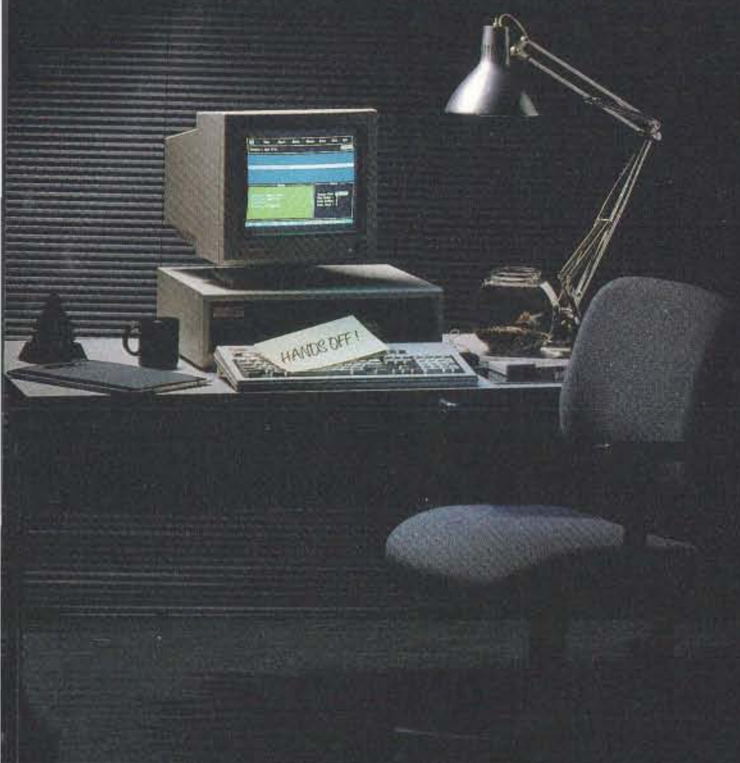
The BYTE news staff is always interested in hearing about new developments that might affect microcomputers, the way they work, or the way people work with them. If you know of a project that could shape the state of the art, please give us a call at (603) 924-9281 or write to us at One Phoenix Mill Lane, Peterborough, NH 03458. An electronic version of Microbytes, offering a wider variety of computer-related news on a daily basis, is available on BIX.



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LETTERS

and Ask BYTE

STOP BIT Pete Wilson

THE WAGES OF SIN

What price has the IBM PC world paid for its compatibility?

Wages of "The Wages of Sin"

Pete Wilson is a hardware jockey ("The Wages of Sin," *IBM Special Edition*, Fall 1989), but the rest of us have work to do. What good is a fast machine with no software? Where are the spreadsheets for the Intel i860 or the i960?

Users have learned that software costs much more than hardware. Wilson has missed the point.

Eugene L. Amazon
Geneva, Switzerland

Pete Wilson's arguments are a rehash of the old RISC insistence that simplicity and elegance of the processor be the absolute criterion. The fallacy of this is that simplicity of the processor creates complexity elsewhere.

Andrew D. Todd
Springfield, OR

Neural Nets and Banking

BYTE quotes Teuvo Kohonen of the Helsinki University of Technology as saying, "You wouldn't want to use a neural net to keep your bank account; they're not accurate enough for that." (Microbytes, November 1989). How odd. For the past 40 years, I've used a neural network once a month to balance my checkbook, and I have never written a check that bounced. I keep this neural network in my head; most people call it a brain.

Wallace B. Riley
San Francisco, CA

Norton Not the First

Stan Miastkowski's article, "Looking Beyond the DOS Prompt" (*IBM Special Edition*, Fall 1989), states that the Norton Commander was the first DOS shell to work with more than one directory at a time. In fact, we pioneered the use of concurrent directory displays in our FileBank Electronic File Cabinets program a year before the Norton Commander was released. "Pathless" file navigation also appeared first in FileBank.

David Highland
Support Station Software
Aspen, CO

In Defense of RISC

I'd like to respond to Dave Nelson's Stop Bit, "RISCs: Unsafe at Any Speed" (November 1989).

RISC architecture is intended to increase overall, rather than average, instruction speed. New efforts at benchmarking by program class show that RISC architecture is very fast in common classes of business and engineering problems.

RISC chips were the first microprocessors to include floating-point instructions. Today's generation of RISCs is at least half an order of magnitude faster at looped transcendentals than complex-instruction-set computer (CISC) chips with coprocessors.

Every special-purpose instruction set costs silicon. Evidence indicates that such instructions are tempting to programmers who often use them where they shouldn't, and that special-purpose instructions are often more effectively implemented in concurrently running coprocessors than in main processors.

Harvard bus architecture and memory caches can both ease the so-called von Neumann bottleneck, whether the processor is RISC or CISC. The bottleneck is a function of the interface between the processor and memory. An argument in favor of RISC is that reducing the silicon devoted to a processor's instruction set can increase the silicon available for improving the data path between processor and memory.

WE WANT TO HEAR FROM YOU. *Please double-space your letter on one side of the page and include your name and address. We can print listings and tables along with a letter if they are short and legible. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

Because of space limitations, we reserve the right to edit letters. Generally, it takes four months from the time we receive a letter until we publish it.

Instruction pipelining originated on CISC processors. High-end RISC processors rely less on pipelines than high-end CISC processors do. Certain RISC processors implement a true single-cycle instruction set without pipelines. Where pipelines are found in RISC processors, they are less complex and more easily tested than pipelines in CISC processors.

The advantage of strongly typed register sets is subjective. I produce more errors trying to remember how data is supposed to behave in a particular register than trying to remember what type of instruction to use on the data type that is supposed to be in a particular general-purpose register.

Every processor architecture, and every attempt at improving an architecture, is an experiment in applied algebra. The engineers who design or modify the architecture must apply a variety of algebraic reductions on all aspects of the architecture to fit it in a physical implementation. Many of the reductions are implicit and are not well understood. Instruction set reduction is well understood. As such, it adds a degree of predictability to the resulting processor. RISC processors are safer, per unit programmer time invested, than CISC processors.

Joel Rees
South Salt Lake City, UT

Kudos for Stop Bit

Congratulations on your new Stop Bit column. In a world of computer magazines that are little more than rubber stamps for their advertisers' products, BYTE continues to stand apart through its inclusion of such features.

R. M. Harrap
Ottawa, Ontario, Canada

Forgotten Pioneer

The IBM Card Programmed Calculator has roots deeper in engineering than

continued

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Circle 26 on Reader Service Card

were described in Hugh Kenner's review of Paul E. Ceruzzi's book, "Beyond the Limits" (Print Queue, November 1989).

During World War II, William D. Bell worked for Lockheed Aircraft's accounting department. A person of great curiosity, he discovered a roomful of people working with mechanical calculators. He investigated and thought he could help them do the work automatically. He labored surreptitiously at night while the accounting department was closed. After several months, he was processing a substantial volume of wind tunnel and stress analysis data. By this time, he required much interconnection between the IBM electromechanical machines. This was a flagrant violation of Lockheed's contract with IBM, and he had to remove his work each night.

The engineer who was receiving this work wrote a memo saying that it was greatly appreciated, but the time had come to put it on a more formal basis. He sent the memo to the head of the accounting department, who was mystified. Caught red-handed, the panicked 19-year-old expected to be fired or even jailed for "sabotaging" these vital machines during a war.

Instead, Thomas Watson, founder of IBM, hired Bill as his personal consultant. From this came the first IBM electronic computing machine, and Bill was hailed as the "father" of the IBM Card Programmed Calculator.

From 1956 to 1959, I had the privilege of working with this very creative man. He was already suffering from multiple sclerosis, which took his life a few years later.

Noel B. Braymer
Rancho Cordova, CA

In Search of Perfection

There is one sentence that stands out in James Hague's letter in the September 1989 BYTE: "Optimization shouldn't compensate for sloppy programming." Why not? There is no such thing as a perfect programmer. Given the best will in the world, no programmer can claim to write bug-free code. Therefore, any tool that can help produce perfection or "correctness" should be welcomed, not castigated.

Michael D. Mitchell
Buckinghamshire, UK

The End of Pascal?

I would like to comment on Jon Udell's "Clash of the Object-Oriented Pascals" (July 1989). I agree that object-oriented Pascal is a surprising development, but I think that Turbo tools such as the source turbo debugger are more useful. Numerous Turbo Pascal extensions are available, but I worry about the future of the Turbo versions.

Turbo Pascal 2.0 comes on one disk; version 5.0 comes on 20 (with toolboxes). In my nightmare I see version 8.0. It occupies 1 gigabyte of disk space and has so many extensions that it's easier to make nonstandard word lists than to enumerate standard ones using the compiler. This version will need a sophisticated expert system in order to do any significant programming.

Standard Wirth Pascal's strength is its simplicity. What happened to the 30-page Pascal manuals? The new manuals are the largest ever.

These new non-Pascal Pascals could result in the destruction of the language. We could lose the best Pascal properties and keep the bad ones. I hope that both Borland and Microsoft do their best and that my fears are groundless.

M. I. Trofimov
Laboratory of Computer Chemistry
N. D. Zelinsky Institute
of Organic Chemistry
USSR Academy of Sciences
Moscow, USSR

I share your concern. Programming languages are getting bigger all the time. I, too, wonder whether I'll be able to lift, much less use, a typical programming toolkit five years hence. And I agree that Pascal's strength is its elegant simplicity. However, Turbo Pascal 5.5 isn't much larger than 5.0. In my view, the object-oriented extensions introduced by Microsoft and Borland confer enormous advantages yet add remarkably little bulk to Turbo Pascal and remain faithful to the spirit of that language.

It's true, of course, that Turbo Pascal has never conformed closely to Standard Pascal. Recently, the British Standards Institute evaluated seven MS-DOS-based Pascal compilers. Only Oregon Software's Pascal-2 and Prospero Software's Pro-Pascal and PC Pascal conformed to the International Standards Organization (ISO) 7185 standard. Visible Software's Dr. Pascal and interpreter did fairly well.

Microsoft Pascal, MetaWare Professional Pascal, and Turbo Pascal performed "quite badly" on the ISO 7185 validation suite. Clearly, if portability is a primary issue, then Turbo Pascal is not a good choice. I'd argue, though, that the object-oriented features of both Turbo Pascal 5.5 and Quick Pascal are well conceived and ought to be incorporated into the international standard.

—Jon Udell

ASK BYTE

OK, I Lied

But not on purpose. In December 1989, David Brammer asked about sound and speech on a PC compatible. Shortly after publication, we heard about the Audio F/X board and Sonata editing software from Forte, a standard PC (Industry Standard Architecture) board that offers 44-kHz sound and up to six simultaneous voices. Audio F/X comes in various flavors, complete with digitizing, playback, and editing software for about $300. You can contact Forte at 72 Karenlee Dr., Rochester, NY 14618, (716) 427-8595.

—H. E.

The Acronym Swamp

Could you provide me with information on the following subjects: ESDI, SCSI, MFM, RLL, and BIOS? I am starting to buy some computer equipment, and all these terms are confusing to me.

Charles E. Green

Sometimes it seems as though the computer industry invented acronyms. It can get confusing.

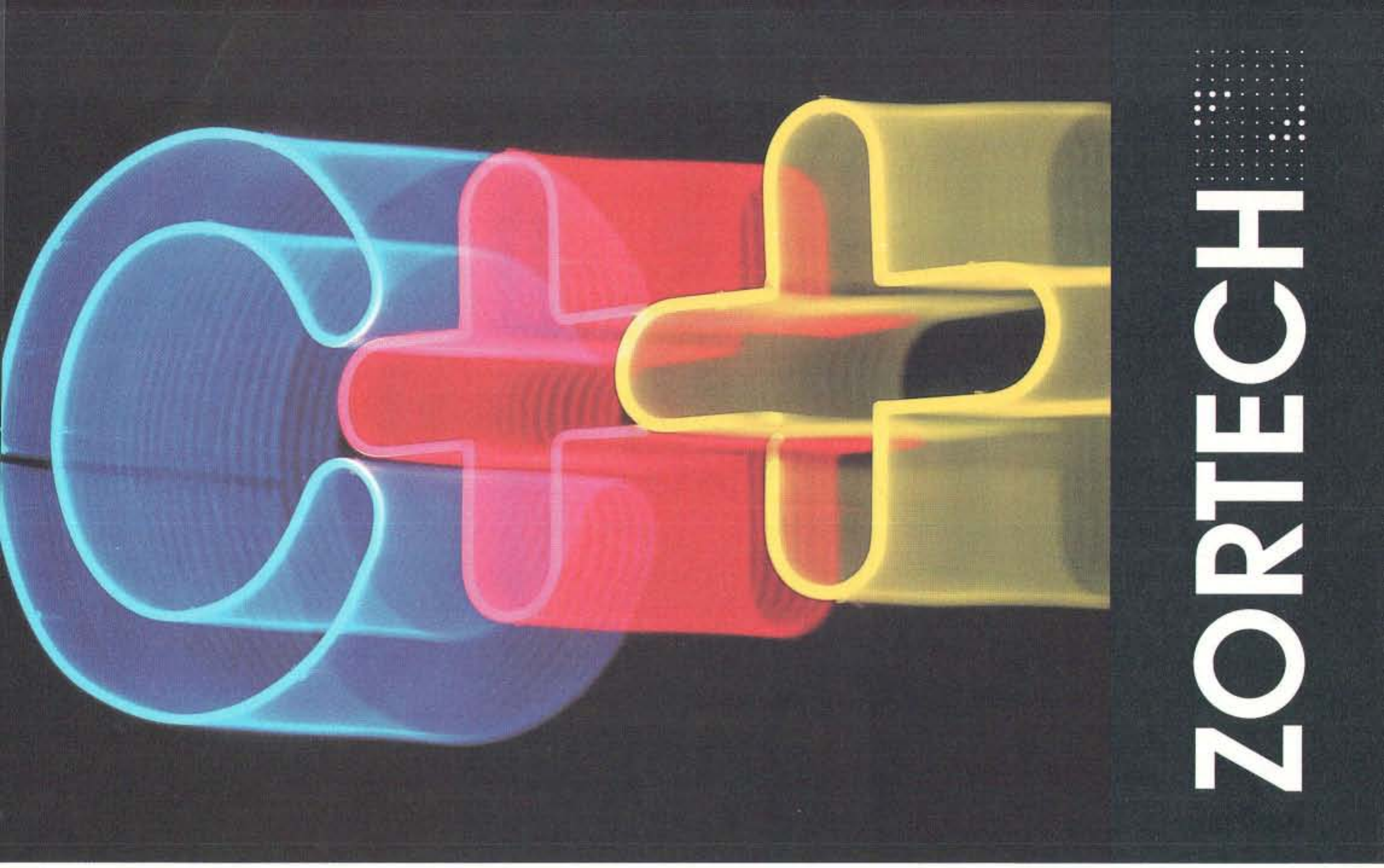
The first few acronyms you mention (ESDI, SCSI, MFM, RLL) concern hard disk drive technology. ESDI (enhanced small device interface) and SCSI (small computer system interface) are methods by which your hard disk drive talks to the hard disk drive controller card in your computer. MFM (modified frequency modulation) and RLL (run length limited) describe the encoding scheme for the data transferred to the controller card. L. Brett Glass fully explains all these terms in "Hard Disk Interfaces" (February 1989).

BIOS (basic input/output system) is the built-in software that your computer uses to talk to its peripherals (screen, disk, printer, and so on). Once again, turn to Glass for a more in-depth explanation ("The IBM PC BIOS," April 1989). Perhaps next month we'll explain DMA, EISA, SQL, RISC, CISC, CMOS, and TGIF!—S. D.

In Search of Strings

I want to develop an application in which arbitrary text strings are placed into a list in alphanumeric order (i.e., ASCII collating sequence). Preferably, the system would allow most of the ASCII characters to appear in the text strings. I want the program to be able to search that list so that I can locate the string nearest to the one I specified in the search request.

continued



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Scott Robert Ladd – Dr. Dobbs Journal – January 1990

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That is, I want to do proximity searching in text containing many—if not most—of the members of the ASCII character set.

I would prefer not to have to write such code myself, mainly because I believe someone else has already done so. Any suggestions?

Robert M. Gordon
Los Angeles, CA

If your final destination is the ability to search an arbitrary text file for strings, the first place you should look is any of the MS-DOS versions of the Unix `grep` *utility. It could be that a "*`grep` *clone" is all you need.*

Otherwise, a number of public domain and shareware utilities may fill the bill. Specifically, look for utilities that are supercharged editions of the MS-DOS Find command. The program Maxfind is one possibility; it allows searches based on incomplete spellings. There are many mail-order companies that sell public domain and shareware programs. One likely place is Computer Solutions (P.O. Box 354, Mason, MI 48854).

Finally, if you've just got to put your data into an index, many of the C toolkits on the market will work. The C Database Toolchest from Mix Software (1132 Commerce Dr., Richardson, TX 75081) comes with everything you need to build B-tree-based index files. You can even get source code, and the programs work with Power C (also from Mix Software), Turbo C, QuickC, and Microsoft C.—R. G.

If You've Seen One Laser Printer . . .

I am considering buying a laser printer and have tested several brands to find one that I can afford with the features I want. I have found that not all programs work well with a given laser printer.

Dot-matrix and daisy-wheel printers can, if you wish, print all the way from the top to the bottom of a page, ignoring any fanfold perforations. Laser printers, on the other hand, have a "hard-wired" top and bottom margin built into their logic circuits. What this means (at least on the printers that I have tested so far) is that a 66-line page (11 inches, 6 lines per inch) has a maximum print length of 60 lines. If you have a program that has a printer driver for LaserJet, you should be all right.

However, not all programs are aware of laser printers. I have discovered two programs that cause the same problem when I print on a laser printer. This problem concerns the way these programs handle the end-of-page-to-top-of-page printing routines. The visible symptom is that, starting with the second page, each page has a large "blank" spot that moves progressively down the printed page. This blank spot seems to correspond to what would be a perforation skip when printing on a printer that uses continuous paper.

What I have deduced from this is that these programs—and probably others as well—use a series of linefeed characters (ASCII 10) to advance the paper from the end of the printing section to the top of the next section. This has the effect of skipping over the continuous paper perforation. Unfortunately, a laser printer—with built-in page-length logic—adds these extra linefeed commands to the printed area of the next page. The solution to this is actually quite easy. Programs can simply send one formfeed command (ASCII 12) in place of several linefeed commands. As far as I know, all types of PC printers recognize the formfeed command.

Does this sound reasonable?

Tom Smith
Vancouver, WA

Yes, it does. In fact, many programs written nowadays do handle the skip-to-next-page by outputting the formfeed character. The nameless software that you refer to is still doing it the old way—by using blank lines, just as you surmised. Your analysis was so thorough that perhaps you should be answering letters for Ask BYTE.

Alas, I can think of several inexpensive printers that still do not recognize the formfeed character. Not that that's reason enough for software to send linefeeds, because it isn't too difficult for a software author to provide the option. Assuming that your dilemma hasn't sworn you off laser printing for good, I may have a fix for you.

The HP LaserJet and compatibles support rather infinite control over their lpi (lines per inch) count. You suggested that the standard printer, at 6 lpi and an 11-inch page, should have 66 lines. Well, even in the "new" math, 6 × 11 = 66, but don't forget those top and bottom margins. The actual printable area of a LaserJet page is about 10.4 inches, allowing for the unprintable region at both top and bottom. By sending out an escape sequence to the printer, you can set a line height less than the standard ⅙ inch, thereby giving the printer the full 66 lines. The 6-lpi figure comes from taking the 11-inch page and dividing it by 66 lines. 66 / 11 = 6.

In this case, take 10.4 and divide by 66, for a new figure of 6.3 lpi. To get the LaserJet to do some magic, we have to put a hex on it—specifically, an escape sequence. The Vertical Motion Index controls the vertical line spacing in increments of 1/48 inch. In this case, you want 7.6/48 inch instead of the usual 8/48 inch (6 lpi).

Before you do that, you also have to account for the margin. You do that by setting the line height to 12/48 inch, setting the top margin to one line, and then resetting the line height to our 7.6/48 inch. Finally, use the lines-per-page command to set 66 lines.

Simply put, you would output the string `[ESC]&l12c1e7.6c66F` *to a LaserJet-compatible printer (where [ESC] is the escape character, an ASCII 27), and that should give you a full 66 lines per page by printing them at 6.3 lpi. The text may be slightly squished, but it should be perfectly readable. You put this string in your software's printer initialization string, or you can run the following GWBASIC program first:*

```
10 LPRINT CHR$(27);
   "&l12c1e7.6c66F";
     : REM Send string to LPT1:
20 SYSTEM
```

Laser printers are truly wonderful toys, and you always discover something new you can do with them. Don't give up on them because of wimpy applications software.—H. E.

Vectra vs. VGA

At my office, we have a fully IBM-compatible VGA card (it works on several other systems). Our computer is a Hewlett-Packard Vectra. Although we have tried many different options and followed the setup instructions carefully, the VGA card doesn't work in the Vectra. Apparently the system does not recognize the card. Do you have any suggestions?

Frederik Wessels
Herwynen, Netherlands

From your description, I can't tell which model of the Hewlett-Packard Vectra you have. The model name Vectra covers a wide range of 80x8, 80286, and 80386 computers. All I can assume is that you have an older Vectra that was released before VGA became available.

There is obviously a conflict between the BIOS in your Vectra and the VGA BIOS on your video card. Try to get an updated BIOS from your local HP dealer. A new set of BIOS ROMs costs approximately $150 U.S., depending on your computer model.—S. W.

continued

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Bits and Bits

Your In Depth discussion of 16 versus 32 bits in the November 1989 issue was excellent. It stimulated me to ask several questions.

First, seasoned programmer friends tell me that running under MS-DOS limits a word fetched from or written to memory to 16 bits, so a 32-bit-wide bus as found in 80386 machines adds nothing to memory access speed. Is this true? Does DOS limit the word length for operands, intermediate results, and so on, as passed between CPU and FPU to the same 16 bits as in RAM access? If so, how many machine cycles, for example, does it take to perform a typical floating-point multiplication or division, as compared to the cycles needed to pass operands from CPU to FPU? I expect that this ratio of FPU execution time to I/O time would be highest in the case of hardwired trigonometrics and transcendentals, less so for multiplies and divides, and least for adds and subtracts.

Tony Finch
Madison, WI

DOS imposes no limits on the size of operands. However, DOS itself is a real-mode program—it cannot take advantage of the extended register set of the 80386 or use 32-bit instructions. Operand limitations are imposed by hardware architecture and development tools, not by the operating system itself.

The processor and coprocessor are connected by a 32-bit data path. Operand transfers involve complex timings, because memory accesses may be involved between transfers; however, at least two clock cycles are required for processor to coprocessor, and three are required in the other direction. These times are quite small in comparison to the number of cycles required for full 80387 instruction execution, which usually ranges in tens of cycles.—S. A.

Electronic Chalkboard

I am paralyzed from the neck down, and I am looking for a program that I can use for algebra, calculus, trigonometry, and physics. My major is architectural technology, which requires me to take many math classes.

I need a program that will let me work through a problem just as you would on paper. It is important that the various math symbols appear on the screen, rather than in coded form. For example, I need a radical sign graphically displayed rather than SQRT( ). I am trying to bypass paper and pencil completely, so I need to be able to visualize the problem as I would when a professor writes it on the chalkboard.

I have heard of the following programs: Mathematica, TK!Solver, MathCAD, Eureka, and TEX. I don't necessarily need a powerful program for solving equations. My main need is for a mathematical word processor.

Thomas J. Swiezy
Indianapolis, IN

If you're using a Macintosh, Mathematica will certainly work, but the cost of the software and memory upgrades that you'd need to run it is great. A more economical solution might be Math Type from Design Science (6475-B East Pacific Coast Hwy., Suite 392, Long Beach, CA 90803, (213) 433-0685). This is a desk accessory that lets you generate tricky mathematical formulas for pasting into your word processing document. As such, it's not much more than an electronic chalkboard.

If you use a PC, MathCAD will do what you need; in fact, it will probably do more than you need. Again, if you're cost-conscious, an alternative is Derive (from Soft Warehouse, 3615 Harding Ave., Suite 505, Honolulu, HI 96816). Derive has substantial symbolic and numeric capabilities; plus, it can display equations the way that you want to see them.—R. G.

Global Communications

I need to communicate with the world. For three years I have tried to work out the problem. I'm on CNCP Dialcom. I was in Saipan and ended up having to call long distance to check E-mail in Canada.

Which is better—Easylink, CompuServe, BIX, or any of the others? Go to a strange city sometime and try looking them up in the phone book; or ask the operator for the local Tymnet number.

International communication is a mess, and I can't find any information to help clear it all up. I still use telex because it's so easy. How can I send E-mail from Dialcom to someone on MCI Mail? After spending hours on Tymnet being denied access into Dialcom, I just phone long distance.

Norm Aylward
Homosassa, FL

International communication is a mess if you're a computer user. There's a lot of conversation about it in the "international" topic on BIX. It seems that if you intend to use a modem in a foreign country across that country's data communications network, you need a network user identifier (NUI). The NUI is your account with that country's network, and getting an NUI is not a trivial task.

As far as sending mail between Dialcom and MCI Mail goes, at the time of this writing, both companies were hard at work linking themselves together. (It should be complete by the time you read this.) MCI's end was just coming online—you send to a Dialcom user by entering "Dialcom" in the EMS address field. A representative of Dialcom told us that the connection would be available by the first of this year. Dialcom's customer-support number is (800) 435-7342.

Finally, if you need information on Tymnet's international connections, just log onto your local Tymnet number and enter "information" at the "please log in:" prompt. This will drop you into a menu-driven information database that can tell you all the countries providing Tymnet connections, as well as cities and phone numbers. Before your next long-distance trip, you might want to check into this database and get all the telephone numbers that you might need.

—R. G. and H. E.

FIXES

- The December 1989 Some Assembly Required column incorrectly stated that JPI TopSpeed Modula-2 terminates strings with a formfeed (CHR(12)). Actually, its strings are terminated with a null (CHR(0)), like C strings.
- There are two corrections to "The BYTE Awards" (January). The TIGA-340 from Texas Instruments was described as a graphics coprocessor card. The TIGA-340 is actually a new software interface, around which graphics coprocessor boards are being built. See the text box "Benchmarking the TIGA" on page 188 of the November BYTE. Also, we inadvertently omitted the name of Quarterdeck Software, which codeveloped the Virtual Control Program Interface (VCPI), a specification that facilitates running multiple 80386-aware programs. Our apologies and congratulations to Quarterdeck and codeveloper Phar Lap Software.
- In the January Connectivity section of What's New, we reported that a twisted-pair Ethernet version of pLAN is available as an option to the thin or thick coaxial versions. In fact, the twisted-pair version is sold separately for $795. Cables are included. For more information, contact IQ Technologies at (800) 227-2817 or (206) 451-0232. ■

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The 386SX from Zeos International includes an American Megatrends BIOS, 512K bytes of RAM (expandable to 4 megabytes on the motherboard), a 32-megabyte Seagate hard disk drive, a 5¼-inch 1.2-megabyte TEAC floppy disk drive, a Hercules monochrome monitor with controller, a 101-key keyboard, and room for expansion.

The 40-pound chassis, which measures 7 by 21 by 17 inches, can house a total of five half-height disk drives and six 16-bit and two 8-bit full-length expansion cards. The disk drive controller is an Adaptec with 8K bytes of cache that supports two floppy disk drives and two hard disk drives. The power unit is a 115-/230-V 200-W design.

Price: $1395.

Contact: Zeos International, Ltd., 530 Fifth Ave. NW, St. Paul, MN 55112, (800) 423-5891 or (612) 633-4591.

Inquiry 1120.

Solid features and expandability in a Zeos SX.

Psion Touts Staying Power of Mobile Systems

Handheld-computer-maker Psion has introduced a new family of "mobile" computers that offer longer battery life, better data storage, and an easier user interface than other "notebook" computers.

The three clamshell-style models each weigh 4½ pounds and are about the size of a ream of paper. All three use a 7.68-MHz 80C86 CPU, eight AA batteries, and new Intel solid-state flash EPROM memory cards for data storage.

Two of the models, the MC-200 and MC-400, employ a proprietary multitasking graphical operating system that uses icons and menus, and they feature a touchpad above the QWERTY keyboard.

The MC-400 comes with more RAM (256K bytes) and a CGA display. Both the MC-200 and the MC-400 have a voice-processing capability for digitizing and playing back speech through a built-in microphone and speaker.

The MC-600 is a DOS-based machine with 768K bytes of RAM, a 1-megabyte RAM disk, an Award BIOS, flash-card slots, and the same display as the MC-400. Instead of the touchpad it has a row of function keys at the top of the keyboard. Battery life is 30 hours. Options include a 3½-inch 1.44-megabyte external floppy disk drive.

Price: MC-200, $799; MC-400, $1499; MC-600, $2499.

Contact: Psion, Inc., 118 Echo Lake Rd., Watertown, CT 06795, (203) 274-7521.

Inquiry 1122.

Psion's 4½-pound MC-400 features a 640- by 400-pixel display, an 80C86 CPU, and power from eight AA batteries.

CD-Based Computers from HeadStart

The new LX-CD and III-CD computers from HeadStart each feature a 5¼-inch 680-megabyte CD-ROM disk drive and bundled disks that are packed with dictionaries, encyclopedias, almanacs, directories, and more. And in the tradition of HeadStart systems, these models include a hard disk drive (40-megabyte) with an already-loaded DOS shell and bundled graphics, spreadsheet, desktop-publishing, and other software.

The LX-CD is a 10-MHz 8088 with 768K bytes of RAM (expandable to 1 megabyte), five full-length 8-bit expansion slots, 256K bytes of video RAM, a 101-key keyboard, and a mouse.

The III-CD is a 12-MHz 80286 with 1 megabyte of RAM (expandable to 3 megabytes), six 16-bit expansion slots (three half-length and three full-length), a 2400-bps modem, MNP software to level 5, and all the other standard features of its little brother, the LX-CD.

Price: LX-CD, $1995; III-CD, $2995.

Contact: HeadStart Technologies Co., 40 Cutter Mill Rd., Suite 438, Great Neck, NY 11021, (516) 482-4255.

Inquiry 1121.

Acer Monitors VGA and 8514/A with AcerView

The AcerView 15P is a 15-inch flat-screen monitor that displays both VGA and 8514/A graphics and the output of all backward-compatible graphics cards. It comes standard with a full-page VGA controller.

Multiscanning ranges from 15 to 70 kHz horizontally and from 45 to 90 Hz vertically. The AcerView 15P supports resolutions of up to 800 by 1000 pixels in full-page mode in 16 shades of gray, and 1024 by 768 pixels in graphics mode. The video bandwidth is 65 MHz.

The add-in board features include 512K bytes of display memory and drivers for Windows/286 and 386, GEM, Ventura Publisher, WordStar, WordPerfect 5.0, AutoCAD, and Lotus 1-2-3. The board also supports TTL standards to run EGA, CGA, MDA, and Hercules.

Price: $1150.

Contact: Acer America Corp., 401 Charcot Ave., San Jose, CA 95131, (408) 922-0333.

Inquiry 1128.

GCC Gives Macs the WriteImpact and PLP II

The WriteImpact is a 24-pin letter-quality printer for your Macintosh. The print resolution is 180 vertical by 360 horizontal dpi. The Personal Laser Printer II (PLP II) is a low-priced 4-page-per-minute QuickDraw laser printer with a 300-dpi resolution. For faster printing, a 1-megabyte RAM module is an available option.

WriteImpact, a 24-pin dot-matrix printer, features 180- by 360-dpi resolution, fonts, spooling, and print management software.

Both printers include six Bitstream outline-font families: Courier, Symbol, Times, Helvetica, Palatino, and Helvetica Narrow. Because it uses outline-font technology, the WriteImpact can scale and rotate each character to any size and angle. The PLP II goes one better with the ability to reduce and enlarge text from 25 percent to 400 percent in 1 percent increments.

WriteImpact also features QuickSpool II, for background printing, and QuickEnvelope, which automatically aligns the address on an envelope and features a database that can hold (and help you manipulate) up to 1000 addresses. Also standard is one ribbon cassette, which prints about 400 pages, and a serial cable. The WriteImpact measures about 6 by 17 by 14 inches and weighs about 19 pounds.

The PLP II gives you QuickEnvelope, Print Manager (for print spooling without a separate processor), and five print options: preview, draft, medium draft, high-quality, and print later. The PLP II also includes an interactive LCD panel.

The PLP II measures approximately 6 by 18 by 18 inches and weighs 24 pounds.

Optional WriteImpact and PLP II font packages include Fonts Plus, Headliners, and Publishers' Choice. Another option on both models is Bitstream's MacFontware converter, which translates MacFontware fonts into a format that you can use with any of GCC's QuickDraw printers. The PLP II also supports Adobe Type Manager, giving you access to any of Adobe's PostScript fonts.

Price: WriteImpact, $699; ribbons, $13; PLP II, $1399; cartridges, $33.

Contact: GCC Technologies, 580 Winter St., Waltham, MA 02154, (800) 422-7777 or (617) 890-0880.

Inquiry 1127.

Lots of Laser Fonts for Less

The LZR-650 laser printer from Dataproducts features 16 built-in fonts, a 300-dpi print resolution, and 512K bytes of RAM (expandable to 4 megabytes).

It prints at 6 pages per minute, has parallel and serial ports, and touts a 3000-page-per-month duty cycle. It also handles 250 sheets in its standard paper tray, emulates Diablo, Epson, and IBM printers as well as Hewlett-Packard, and has a footprint of 1⅓ square feet.

Price: $1695.

Contact: Dataproducts Corp., 6200 Canoga Ave., P.O. Box 746, Woodland Hills, CA 91365, (818) 887-8000.

Inquiry 1130.

Low-Cost Laptop Printer

The OIP-200 Lapmate is a dot-matrix printer that prints text at 28 cps and graphics at 180 dpi. Including the rechargeable nickel-cadmium battery that lasts up to 3 hours, it weighs about 3 pounds and measures 1⅛ by 5 by 12 inches. It prints on 8½-inch-wide thermal paper and connects to a parallel port.

The OIP-200 employs a bidirectional 24-pin print head and prints 96 ASCII characters using standard Epson escape codes. Type options include Pica, Elite, Condense, Enlarge, and Proportional. Line spacings can be ⅙ or ⅛ inch.

Price: $349.95.

Contact: S.L.S. Technology, Inc., 245 Pegasus Ave., Northvale, NJ 07647, (201) 784-0987.

Inquiry 1129.

continued

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We'd like to consider your product for publication. Send us full information, including price, ship date, and an address and telephone number where readers can get further information. Send to New Products Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Information contained in these items is based on manufacturers' written statements and/or telephone interviews with BYTE reporters. BYTE has not formally reviewed each product mentioned. These items, along with additional new product announcements, are posted regularly on BIX in the microbytes.sw and microbytes.hw conferences.

"Business Imaging System" Uses Windows Imaging Model

The Exact-2000 is a single-slot AT-bus board that provides both display control and laser-printer control. A daughtercard controls a scanner, which lets you scan and print directly (without crossing the bus).

By using the Microsoft Windows Graphical Device Interface imaging model for printer control, the Exact-2000 skips the time-consuming process of converting pages to HP PCL or PostScript, while transparently supporting Windows applications such as Aldus PageMaker, Micrografx Designer, Corel Draw, Computer Solutions Arts & Letters, and the AGA family of image retrieval systems.

The core Exact-2000 board contains a 40-MHz Texas Instruments 34010 processor, 2 to 4 megabytes of DRAM, and 1 megabyte of video RAM. It can control both a 1600- by 1200-pixel display (Alacrity sells a 19-inch full-page monochrome model) and a laser printer.

Using Bitstream fonts, the Exact-2000 can create on-the-fly scalable, rotatable fonts on your screen for WYSIWYG representation and then use the same outlines to print the page to non-PostScript printers. Alacrity claims that Exact-2000's raster image processor can print, in as little as 40 seconds, pages that would otherwise take 20 minutes.

Price: Printer- and display-only boards, $1695 each; core board, $2395; scanner daughtercard, $395 to $550; 19-inch monitor, $995.

Contact: Alacrity Systems, Inc., 88 Bartley Sq., C-6, Flanders, NJ 07836, (201) 584-0116.

Inquiry 1132.

VGA and 8514/A in a Single Chip for One Board

The TAVA 9000 and the TVGA 8900 are 8514/A-VGA and Super VGA (800- by 600-pixel) boards that use the manufacturer's own video chips.

Trident claims that the TVGA 8900 is the first board with "on-chip power" to drive 1024- by 768-pixel graphics in 256 colors, noninterlaced. Such high-resolution graphics require the optional 1 megabyte of DRAM. With less RAM, the standard 8900 is capable of running 800- by 600-pixel graphics in 16 colors or 640- by 480-pixel graphics in 256 colors with as few as six support chips, including two 256K-byte DRAM chips. A key feature involves a proprietary 32-bit video memory bus on the card and an internal cache with an intelligent sequencer.

The TVGA is unique, Trident says, because it uses a clock chip rather than a crystal oscillator. This offers an advantage by allowing the generation of up to eight different clock frequency outputs. One of these frequencies can be used as a DRAM clock to increase DRAM speed. Monitor compatibility is ensured through an optional serial electrically erasable programmable ROM rather than in BIOS EPROMs.

The Trident Advanced Video Array 9000 combines both 8514/A functions and VGA functions on a single chip and is register-level compatible with IBM's 8514/A, VGA, EGA, CGA, MDA, and Hercules. Supported resolutions include 1024 by 768, 800 by 600, and 640 by 480 pixels, in 16 and 256 colors.

Each TAVA will support all 8514/A functions, including line draw, block transfers, polygon fill, and bit-mapped text.

Optional software drivers are available for Lotus 1-2-3, PageMaker, Ventura Publisher, WordPerfect, WordStar, Microsoft Windows, GEM, Framework II, and AutoCAD.

Price: TVGA 8900, $359; TVGA 8900 with 1 megabyte of RAM, $595; TAVA, $795.

Contact: Trident Microsystems, Inc., 321 Soquel Way, Sunnyvale, CA 94086, (408) 738-3194.

Inquiry 1134.

Computer Boards Aim at MetraByte's DAS-16

The CIO-AD16/50K and /100K are data acquisition boards that are compatible with MetraByte's DAS-16 boards.

Features include simultaneous sample and hold for separately and simultaneously triggering up to 16 analog channels, support for 32 digital I/O lines, analog inputs of up to 16 channels of single-ended input or eight channels of differential input, a counter/ timer with three counters of 16 bits each, two 12-bit D/A converters, and triggering through internal and external means and through software.

Price: 50 kHz, $799; 100 kHz, $859.

Contact: Computer Boards, Inc., 44 Wood Ave., Mansfield, MA 02048, (508) 261-1123.

Inquiry 1135.

CD-Quality Digital Audio System for Your Mac II

Audiomedia is the first low-priced, NuBus-based, digital audio recording and editing system for the Macintosh II, according to the manufacturer.

It features the Motorola 56001 digital signal processor used in the NeXT computer, and sound-editing software that lets you edit stereo sounds from microphones, compact disk players, and other sources.

The NuBus board has two RCA line-in and line-out jacks. Audiomedia also supports sampling rates of up to 44.1 kHz, the sampling rate frequency used for CD-quality digital audio. You can specify lower sampling frequencies to keep disk storage requirements low and to record lower-fidelity sounds such as voice and sound effects. Sounds recorded at the 44.1 kHz sampling rate require 10 megabytes of disk space per minute of sound.

Audiomedia supports HyperCard stacks and Apple's Sound Manager utility, so you can use sounds recorded with Audiomedia with other Mac software applications that support sound, such as the Macromind Director video animation program or the WingZ spreadsheet program. Audiomedia also includes its own software for music editing.

Price: $995.

Contact: Digidesign, Inc., 1360 Willow Rd., Suite 101, Menlo Park, CA 94025, (415) 327-8811.

Inquiry 1133.

continued

DBMS Case Study:

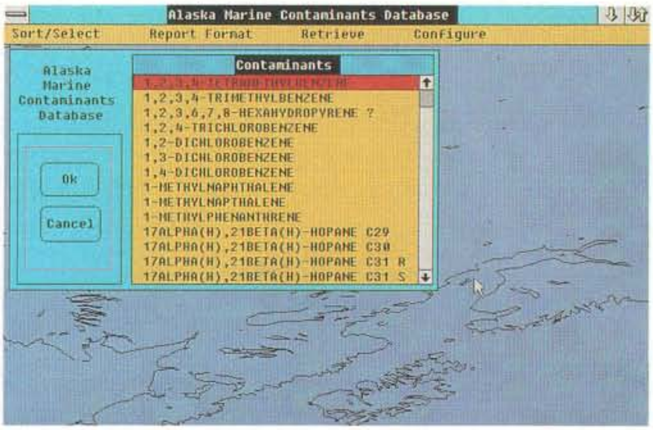
The Exxon Valdez Disaster

March 24, 1989. Exxon VALDEZ tanker runs aground, creating the worst oil spill in U.S. history. 11,000,000 gallons contaminate the pristine waters of Alaska's Prince William Sound.

The Problem Major disasters, like the Exxon Valdez spill, require quick response based on careful data analysis. Fortunately, an easy-to-use database was already being created which would help.

The Application The Alaskan Marine Contaminants Database lets oceanographic chemists easily access 60 megabytes of data covering the past decade. The database is provided free of charge on CD-ROM, and the Windows interface means they can get right to work, assessing damage to the ecosystems of Prince William Sound and other Alaskan waters.

The Solution db_VISTA III is the only DBMS with the features this project required: C language support, Windows compatibility, royalty-free runtime distribution, quick performance in large databases, quality documentation and support. With the Alaskan Marine Contaminants Database, the difficult job of calculating the long-term effects of the Exxon spill is a little easier.*



Alaska Marine Contaminants Database
Sort/Select
Report Format
Retrieve
Configure
Contaminants
Alaska Marine Contaminants Database
Ok
Cancel

```
1,2,3,4-TETRAMETHYLBENZENE
1,2,3,4-TRIMETHYLBENZENE
1,2,3,6,7,8-HEXAHYDROPYRENE ?
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
1-METHYLNAPHTHALENE
1-METHYLNAPTHALENE
1-METHYLPHENANTHRENE
17ALPHA(H),21BETA(H)-HOPANE C29
17ALPHA(H),21BETA(H)-HOPANE C30
17ALPHA(H),21BETA(H)-HOPANE C31 R
17ALPHA(H),21BETA(H)-HOPANE C31 S
```

A Microsoft Windows front end lets chemists select regions from a map to retrieve data. And, db_VISTA III's SQL-based query and report writer lets users perform complex SQL data searches.

Your DBMS problems may not make the headlines, but they are no less important and often no less challenging. If you develop applications for MS-DOS, MS Windows, UNIX, VMS, QNX, OS/2, Macintosh, and other environments, db_VISTA III is your solution.

Call 1-800-db-RAIMA (1-800-327-2462)

* Reprints of the story, as published in PC Week and Data Based Advisor, are available from Raima.

db_VISTA III™

Database Management System

Specifications: ***Complete C source code available. No Royalties***
C Lanaguage Portability & High performance

Network Data Model. Relational B-tree indexing. Relational SQL query and report writer. Single & Multi-user. Automatic recovery. Built-in referential integrity. Complete revision capability. **Supports:** MS-DOS, MS Windows, UNIX, QNX, SunOS, XENIX, VMS, Macintosh. OS/2 compatible. **Most C Compilers supported.** **LANs:** 3COM, Novell, Banyan, Appleshare. Call for other environments.

Power Tools For C Programmers

RAIMA™
CORPORATION

db_VISTA III DBMS rated number #1

For Performance and Flexibility of DBMS Programming Tools-
PCWEEK Poll of Corporate Satisfaction, August 28, 1989.

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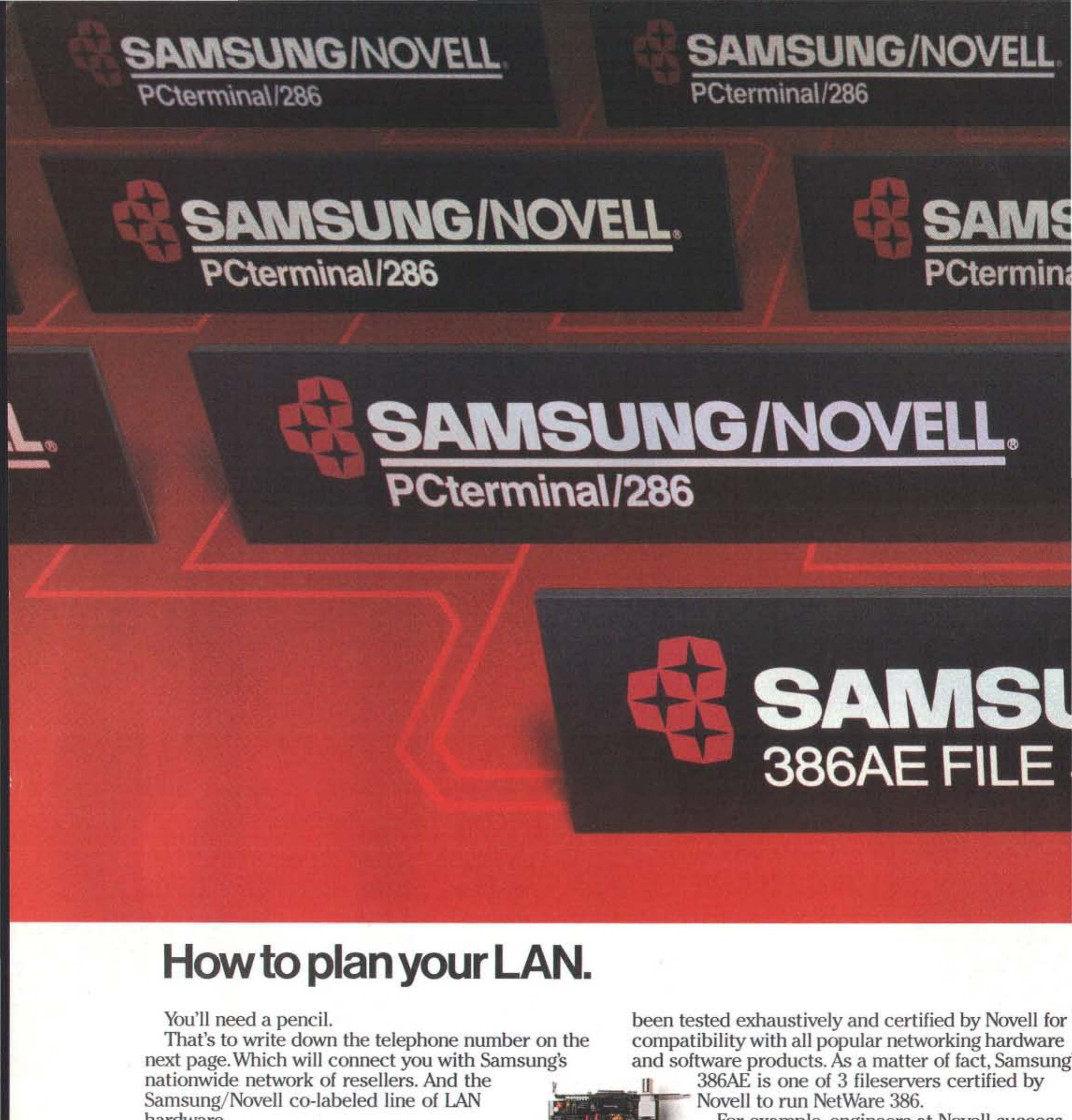

How to plan your LAN.

You'll need a pencil.

That's to write down the telephone number on the next page. Which will connect you with Samsung's nationwide network of resellers. And the Samsung/Novell co-labeled line of LAN hardware.

It's pretty much that simple.

With one call you can plan on substantial savings over the big name computers which, despite high clock rates and even higher price tags, are not really optimized for networking.

And you can plan on 100 percent compatibility with all versions of Novell's NetWare,® because Samsung's LAN hardware was co-designed by Novell. Just like the label says.

THE TESTING WENT IN BEFORE THE LABEL WENT ON.

Both the Samsung 386AE and PCterminal/286 have been tested exhaustively and certified by Novell for compatibility with all popular networking hardware and software products. As a matter of fact, Samsung 386AE is one of 3 fileservers certified by Novell to run NetWare 386.

For example, engineers at Novell successfully tested the PCterminal/286 LAN Workstation in no less than 1200 different network configurations… with 50 units running at once! That's a claim no other computer manufacturer can make.

NETWORKING VS. NOTWORKING.

What's the difference? Take our 386AE Fileserver, for instance. It includes Novell's Advanced BIOS, and eight expansion slots to accommodate multiple network interface cards and disk controllers. Plus an oversize power supply capable of driving dual high capacity hard disks and tape

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back-up system. Plus 4 megabytes of main memory for disk caching.

Then there's Samsung's PCterminal/286 Diskless Workstation which includes a built-in Ethernet interface and Novell's Remote Boot EPROM.

And not to be overlooked is our 16-bit SE2100 Ethernet Interface Card which provides up to twice the throughput for the price of an 8-bit card.

THE SAMSUNG COMMITMENT.

With 4 million monitors and half a million PC and LAN computers sold in 1988 alone, it's clear that Samsung has made a serious commitment to the marketplace. In all, Samsung offers no less than nine different PC and LAN computer models with seventeen color and monochrome monitors! And, as a 31-billion dollar international corporation, Samsung has the resources to provide continuous support for its customers.

So why not begin your network planning today? For the name of the Samsung reseller nearest you, write:

SAMSUNG, 3655 North First Street, San Jose,
CA 95134, or call **1-800-446-0262.**

SAMSUNG

Circle 245 on Reader Service Card (DEALERS: 246)

Make Your SCSI a GPIB Port

The GPIB-SCSI is a modem-size SCSI–to–general-purpose interface bus translator box that lets you control up to 14 GPIB instruments from a single SCSI port.

Two buffer options are available, and at least one is required for a key disconnect/reconnect feature that allows you to disconnect from the SCSI bus and still continue to communicate with the GPIB instrument. This ensures that the performance of the SCSI bus doesn't suffer because of the slower GPIB instrument.

The GPIB-SCSI has a built-in DMA controller for transferring data at rates of up to 900K bytes per second. It also supports all GPIB controller functions as well as normal and extended talker and listener addressing, serial and parallel polls, service requests, and passing and receiving control. It implements all the SCSI bus phases, including arbitration and selection/reselection phases, asynchronous data transfer, and parity generation with optional checking.

Although drivers aren't necessarily needed, they are available for the DEC VAXstation, the Sun SPARCStation 1, and Macintosh computers.

If you want to work with SCSI devices, you can flip a switch and make the GPIB-SCSI an interface for SCSI devices to talk to dedicated GPIB controllers. You can use the GPIB-SCSI this way to interface up to seven SCSI devices.

Price: Without RAM, $695; with 64K-byte RAM buffer, $795; with 256K-byte RAM buffer, $995.

Contact: National Instruments, 12109 Technology Blvd., Austin, TX 78727, (800) 433-3488 or (512) 794-0100.

Inquiry 1139.

GPIB-SCSI interface controls GPIB devices better.

Replace Your Power Unit with Power and UPS

The EP-550 is a 200-W power replacement unit for your AT that includes a standby power supply. You simply replace your power supply with the EP-550.

Maintenance-free batteries provide 5 to 10 minutes of backup power to your CPU's DC logic circuits and to the AC monitor. Power is 150 V AC at 60 Hz, and the unit accepts voltages from 80 V AC to 260 V AC and frequencies from 47 to 440 Hz. Optional equipment includes DOS-based software and an interface card for automatic shutdown.

Features include a battery charger, overcurrent protection, overload and short-circuit protection, and an audible alarm to warn you of power failure. Units are also available for Compaq, Zenith, and Apple computers.

Price: $795.

Contact: Enpower Corp., 7929 Silverton Ave., Suite 610, San Diego, CA 92126, (800) 322-7697 or (619) 536-9011.

Inquiry 1140.

Safe Computing Claims Radiation-Free Monitor

Safe Monitor is a backlit LCD for XT, AT, PS/2, and Macintosh computers that's compatible with CGA and VGA controllers, offering 4 and 16 shades of gray, respectively. The screen measures 10 inches diagonally, and the unit weighs 15 pounds.

Safe Computing claims that the monitor blocks several types of radiation, including electric and magnetic radiation, x-rays, and static buildup. The key to blocking radiation is a patented mesh wiring that stands between you and the pixels. It also blocks 30 percent of the light that's emitted, but Safe Computing says that the screen remains quite readable.

An optional device, Safe Meter, can measure low-frequency magnetic radiation in two different bands of frequencies: from 20 to 50,000 Hz and from 300 to 50,000 Hz.

Price: $695; Safe Meter, $145.

Contact: Safe Computing Co., 368 Hillside Ave., Needham, MA 02194, (800) 222-3003 or (617) 444-7778.

Inquiry 1141.

Easy Power-On for Your Mac

The PowerKey is a smart power-on device for Macintosh systems and peripherals that lets you program specific on/off times. It also serves as a surge suppressor, noise filter, and overload protector.

PowerKey works with the Mac SE, SE/30, II, IIx, IIcx, and IIci. Rated voltage is 125 V AC, current is 15 amps, peak power dissipation is 1.5 kw, energy rating is 70 joules, current peak is 6500 amps, and the circuit breaker is 15 amps.

Price: $99.

Contact: Sophisticated Circuits, Inc., 19017 120th Ave. NE, Suite 106, Bothell, WA 98011, (206) 485-7979.

Inquiry 1144.

Flexible Digitizing Mat Is 1/32-inch Thick

The 4-ounce Grid Master Digitizing Mat is flexible, is only 1/32-inch thick, and can be rolled up like a poster.

With a four-button cursor and a slide-switch pen included, it gives you a resolution of 1000 lines per inch with accuracy to 0.01 inch, Numonics claims. It also maintains absolute positioning with all software and remembers its configuration even with the power off.

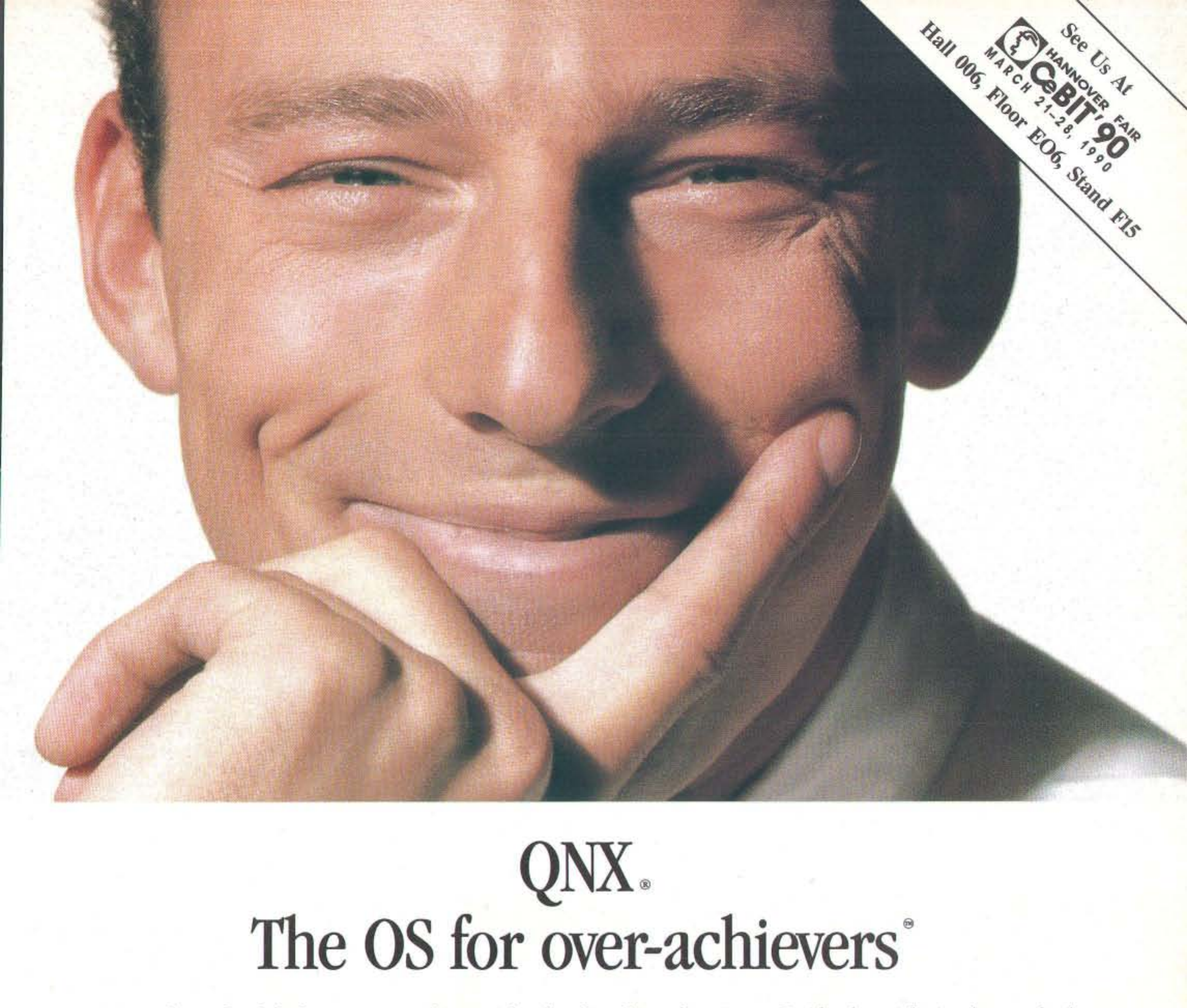
Included is an RS-232C cable, a setup menu template, and drivers for the Microsoft Mouse and Windows. A Macintosh adapter is also available.

Price: With cursor, $469; with pen stylus, $449.

Contact: Numonics Corp., 101 Commerce Dr., Montgomeryville, PA 18936, (215) 362-2766.

Inquiry 1143.

continued



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QNX®
The OS for over-achievers℠

QNX programmers have a decided advantage.

You see, people who use QNX enjoy the freedom that comes only with a flexible, modular OS. They appreciate the elegance of a **message-passing architecture**. And they marvel at the fact that QNX runs so lean — under 150K— yet out-performs any other PC operating system.

QNX users never worry about whether their applications will make it at runtime, because they know QNX has proven itself again and again in the real world.

It's no wonder that QNX users have achieved so much since the product was first released for the PC in 1982: over 80,000 systems installed in 47 countries world-wide, in all kinds of applications — from making cars to selling books to handling online credit card transactions.

One reviewer dubbed QNX "The multi-everything OS." Now, you might expect multiuser and multitasking, but realtime? *And* integrated networking? *And* true distributed processing? Best of all, these terms take on a new meaning with QNX.

Multiuser, for instance, means up to 32 terminals per micro. **Multitasking** cashes out as 150 tasks per machine. **Realtime** means not only priority-driven, preemptive task scheduling, but also speed: at 6,896 task switches/sec on a 16MHz 286, QNX is at least a full order of magnitude faster than a typical UNIX system. **Integrated networking** means you won't need yet another layer of software to set up a LAN, and you can use *any mix* of Intel-based micros — from vintage '81 PCs to PS/2s.

Distributed processing with QNX sounds too good to be true. But it is: *Any task can access any resource* — programs, files, devices, even CPUs — without going through the bottleneck of a central file server.

Besides the satisfaction that QNX developers get from using a fast, powerful, and flexible OS, did we mention that they also enjoy *free technical support?*

If you're wondering why you don't already know all about this great OS, you could try asking the over-achievers who are smugly guarding the secret of their success.

Better yet, give us a call. We'll tell you everything you need to know to become an over-achiever yourself.

QNX

For more information or a free demo disk, please phone (613) 591-0931.

Quantum Software Systems Ltd., 175 Terrence Matthews Crescent, Kanata, Ontario, Canada K2M 1W8

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Circle 233 on Reader Service Card

Telebit Offers New Cellular Modem

The CellBlazer is a high-speed modem designed to send and receive data via the cellular telephone network. The external version of the unit is attached by a jack to a standard cellular phone. The internal unit, the CellBlazer PC, is an 8-bit card for laptops.

Several of CellBlazer's functions were designed specifically for cellular communications, Telebit says. For example, its multicarrier modulation can alleviate problems associated with the "hand-offs" necessary for mobile communications when a call is switched from one cellular station to another. And a function called Packetized Ensemble Protocol (or PEP) error correction is suited to handling such cellular problems as distortion, interference, and fade-outs. The packets are also split across many carriers, so the data rate on any given frequency is quite low, and that helps overcome delay distortion, signal fading, and impulse noise.

The modem also runs tests on the line and determines which frequencies are the most and least distorted. The transmission scheme is then adjusted to send more packets on the clearer frequencies and fewer or none on the poor ones. Telebit claims that these provisions permit the CellBlazer to establish, maintain, and optimize connections on lines that are unsuitable for ordinary modems. Many V.32 modems, for example, drop from 9600 to 4800 bps when they encounter poor line quality; Telebit's PEP lowers speed in 100-bps increments to sustain the highest possible rate for a given connection.

Telebit's CellBlazer connects you through the cellular network or through standard hard-wire telecommunications.

Under good conditions, the CellBlazer can communicate over cellular lines at up to 16,800 bps, Telebit says. You can also use the modem for regular land-line transmission at up to 19,200 bps.

Price: Internal modem card, $1295; external unit, $1495.

Contact: Telebit Corp., 1345 Shorebird Way, Mountain View, CA, 94043, (800) 835-3248 or (415) 969-3800.

Inquiry 1145.

New Program Manages Files on a Network

The new PerfectSolution is a network-based document management system for IBM-compatible machines that can handle all types of data files—not just documents, but spreadsheets and graphics files as well. It's compatible with Novell, 3Com, Banyan, and IBM Token Ring LANs.

One of PerfectSolution's key features is its full-text indexing, which the company claims is fast, dynamic, and based on a small index. For its searching capabilities, SoftSolutions has licensed a technique, called SpeedSearch, that uses a compressed index that never gets to be more than 5 percent of the size of the original text.

Like other document management programs, PerfectSolution keeps a "profile" on every data file. The company says its program can locate any file on any server or client anywhere on the network. PerfectSolution resides on both the server and the DOS workstation, which must have 640K bytes of RAM.

Price: Server, $2495; per workstation, $295.

Contact: SoftSolutions, Inc., 625 South State, Orem, UT 84058, (801) 226-6000.

Inquiry 1146.

Control Remote PCs

Network Operator is a software package that lets you remotely control up to 10 PCs on your NetBIOS-compatible network, or one other PC through a remote modem or other wide-area network type of connection.

Once you're in control of that other PC, you can manipulate its screen within windows on your screen, in resolutions up to the VGA standard. The windows can also be enlarged to show the entire screen of the system you're controlling, or you can downsize them to fit all the screens on your screen.

NetOp uses only 1K byte of RAM on the remote system and 240K bytes of RAM on your master system.

Price: Site license, $695.

Contact: International Intergroup Ltd., 1777 South Harrison St., Suite 500, Denver, CO 80210, (303) 692-9090.

Inquiry 1147.

TOPS E-Mail Enhanced

InBox 3.0 and InBox Plus are redesigned E-mail packages from Sun Microsystems' TOPS division. Enhancements include better compatibility with multiple hardware and operating-system platforms, the company says.

TOPS has also announced gateways to public mail systems like MCI Mail, GEnie, and CompuServe and to mainframe and mid-level system-mail packages like IBM's PROFS, DEC's All-In-One and VMS Mail, and SMTP on Unix-based systems.

InBox 3.0, which requires no central administration and is optimized for fewer than 20 users, enables both PCs and Macs to act as servers to store each other's mail. It runs on NetWare, 3Com 3+, Microsoft LAN Manager, Apple's AppleShare, and TOPS/DOS and TOPS/Mac. Other features include personal address books, personal mail management, storage boxes, and the ability to enclose multiple documents (whether they're text, graphics, or spreadsheets).

InBox Plus is designed to support up to 100 users per message center and to route mail from server to server. InBox Plus allows almost any computer on the network to act as a message center, from DOS and Macintosh systems to Unix and DEC VAX systems.

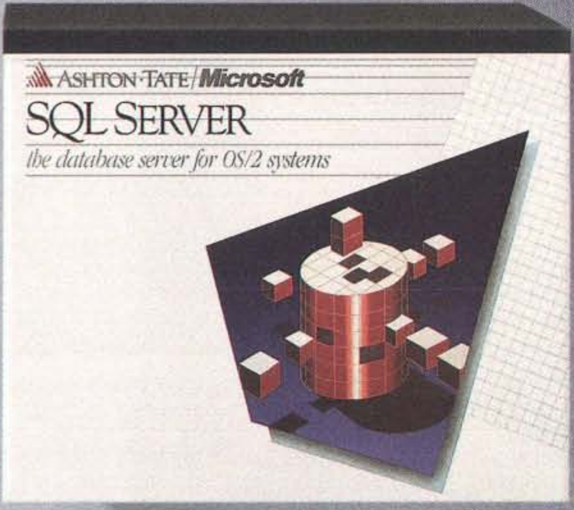
Price: InBox 3.0, $329 per site; InBox Plus, $995 per site.

Contact: Sun Microsystems, TOPS Division, 950 Marina Village Pkwy., Alameda, CA 94501, (415) 769-9669.

Inquiry 1152.

continued

Open Server. Closed Server.



Runs on every vendor's operating system: OS/2,™ VINES,® UNIX,™ VAX® VMS, IBM® MVS, etc.	Runs only on OS/2.
Supports every vendor's local area network protocol: Novell's® SPX/IPX,™ NetBIOS, Named Pipes,™ etc.	Supports only Named Pipes.
Transparent access to data in other vendor's databases: IBM's DB2™ and SQL/DS, and Digital's RMS.	Does not provide access to any other database.
Transparent data sharing between all your computers: PCs, minis and mainframes.	Can't even transparently share data between two PCs running Ashton-Tate SQL Server.
Your Lotus 1-2-3® spreadsheets and dBASE® applications work with ORACLE Server today.	Doesn't work with either Lotus 1-2-3 or dBASE just yet.
Developers have a complete and integrated family of portable tools for CASE, applications generation, report writing, etc.	Supports only Focus.
Programmers can use interfaces from C, COBOL, and FORTRAN.	Supports only C.
ORACLE Server is certified by Codd and Date to run at 11.0 TP1 transactions per second.	Ashton-Tate SQL Server's published benchmarks show it to be slower.

Call 1-800-ORACLE1, ext. 4965 today and order ORACLE Server for OS/2
for only $2499 and get six months of phone support and upgrades for free (a $500 value).
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Network Scheduling to Enhance Group Productivity

PowerCore has enhanced its Network Scheduler II 1.11 to let you combine the scheduling of people and resources with Why and Where options to display the reason for and location of scheduled events. Network Scheduler is compatible with Novell, 3Com, and Banyan.

Version 1.11 works with or without E-mail such as cc:Mail, 3+, 3+Open Mail, and Message Handling Service–compliant services such as Da Vinci eMail and Action Technologies' The Coordinator II. Network Scheduler also supports wide-area networks through MHS-compatible networks, and the menu is designed to be compatible with IBM's Systems Application Architecture/Common User Interface.

A 4K-byte TSR program now lets you hot-key between your applications and Network Scheduler.

PowerCore enhances groupware so everybody shares data.

Other main features include support for remote users, easy insertion of recurring appointments without multiple entries, reminder notes, and programmable levels of security.

Price: For eight users, $495; for 25 users, $695; for 50 users, $995.

Contact: PowerCore, Inc., One Diversatech Dr., P.O. Box 756, Manteno, IL 60950, (800) 237-4754 or (815) 468-3737.

Inquiry 1150.

Finalsoft Synchrony 1.0 is a comprehensive software package designed for group productivity that is compatible with DOS, Microsoft Windows, NetBIOS LANs, and MHS.

It features personal and public functions, and mixes of the two. Synchrony comes with an agenda, a group scheduling function, a multidocument text editor, a multiuser database, a document creation and management function (whether text, pictures, or spreadsheets), and E-mail.

Price: For six users, $445; for 10 users, $695; for unlimited users, $1995.

Contact: Finalsoft Corp., 3900 Northwest 79th Ave., Suite 215, Miami, FL 33166, (800) 232-8228 or (305) 477-2703.

Inquiry 1151.

RightWriter Now Checks Your Prose over Your LAN

A NetWare-compatible version of the grammar-checking software RightWriter now lets you share one copy among five colleagues.

It's the same RightWriter that's been available for DOS and Unix systems, with advanced parsing and an expert system that includes more than 4500 rules.

RightWriter checks your documents for errors in grammar, writing style, usage, and punctuation. It will tell you, for example, that "consensus of opinion" is redundant. And it includes features that let you customize rules or even turn them on or off so it won't flag every entry of "NeXT Computers" as unusual capitalization, for example.

Price: $285.

Contact: RightSoft, Inc., 4545 Samuel St., Sarasota, FL 34233, (813) 923-0233.

Inquiry 1148.

continued

IBM Package Lets Hearing-Impaired People Communicate by Phone

The PhoneCommunicator is a hardware/software product that lets hearing-impaired people send voice messages from PCs and receive written replies from the keypad of a Touch-Tone phone.

Many hearing-impaired people now use Telecommunication Devices for the Deaf (TDD) terminals (small acoustic couplers with keyboards and screens) for conversation with one another and with organizations that offer TDD access, but most hearing individuals don't have such terminals. One common way to reach hearing people is through "relay" services, offered by AT&T and other companies, in which an operator reads typed messages from a hearing-impaired caller aloud to the hearing person and then types back the spoken replies. Relay service is available only in certain regions at certain times of the day, and it has drawbacks, including cost and lack of privacy.

The PhoneCommunicator runs on a PC or PS/2 (Models 25 and 30) under DOS and consists of a multifunction board and software. The board has a modem for communication to ASCII BBSes or TDD devices, a voice synthesizer for speech output, and an auto-answer function that records and time-stamps incoming text messages when nobody is present to receive them.

The software provides a character-based interface for sending and receiving messages. To talk, the hearing-impaired person types words on the keyboard and the voice synthesizer speaks them over the phone. To respond, the hearing user enters letters on the telephone keypad.

You can initiate outgoing calls manually or use a built-in auto-dialer with a phone list. The user will typically begin the call with a preprogrammed message that identifies him or her as hearing impaired and gives instructions on how to respond using the phone keypad. When a call is incoming, the screen flashes to alert the hearing-impaired user, and the synthesizer greets the caller with a programmed message. All conversations can be saved to disk.

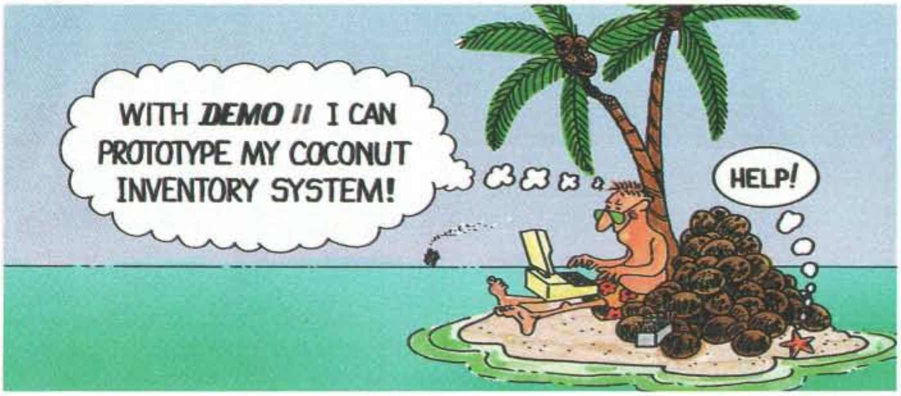
Price: $600.

Contact: IBM National Support Center for Persons with Disabilities, P.O. Box 2150, Atlanta, GA 30055, (800) 426-2133 (voice) or (800) 284-9482 (TDD).

Inquiry 1154.

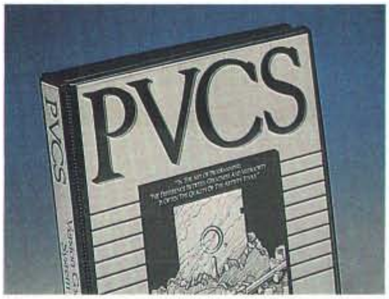
SAGE SOFTWARE

It's Sage Software month at Programmer's Paradise


WITH *DEMO II* I CAN PROTOTYPE MY COCONUT INVENTORY SYSTEM!
HELP!

DEVELOPMENT POLYTRON TOOLS

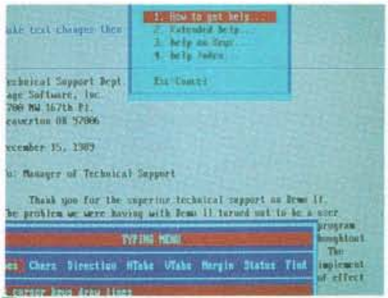
Sage Software has merged with Polytron and acquired exclusive rights to publish Dan Bricklin's ® Demo II™ and Plink86+. Sage is one of the fastest growing suppliers of "Best In Class" software development tools. And remember the best place to buy Sage tools - Programmer's Paradise.



PVCS

The Polytron Version Control System (PVCS) provides complete control over the configuration of your software and all its elements. Previous configurations are easily recovered at any time. Conflicting module changes can be detected or avoided. You always know who made a change, what it was, why it was made, and what revisions contain the change. You can coordinate revisions, special versions and upgrades - automatically.

PVCS is the market leader in version control. Our user list reads like a Who's Who of software development. The new version (3.2) adds fine-grained file and function security; enhanced parallel development support; and an even higher degree of customization and configuration control.

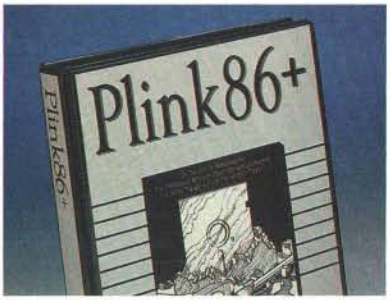


Dan Bricklin's® Demo II

Demo II is the perfect tool for:

- Creating realistic demos of your product without releasing any active code.
- Prototyping systems before coding them to ensure they meet users needs and expectations.
- Building tutorials or even full-blown Computer Based Training products.
- Any application where you need a way to simulate the action of a live program without creating or supplying the program.

Dan Bricklin's Demo II is a powerhouse prototyper, tamed by a superb interface. The rich control language permits complex demos so realistic that users will believe they are using an actual program. While any programmer will quickly feel right at home with the control language, it can be ignored completely for simpler demos, tutorials or prototypes.



Plink86+

Over 20,000 programmers rely on Plink86+ to manage program memory and to link large applications. Plink86+ is time tested, evolved technology with extensive capabilities to improve your software. It is more than just an overlay linker - it's an overlay editor, permitting you to quickly try different structures.

It's the industry standard overlay linker, so you know your application will run on the largest number of PCs. You can create programs as large as 16 MEG to run in as little as 192K of memory.

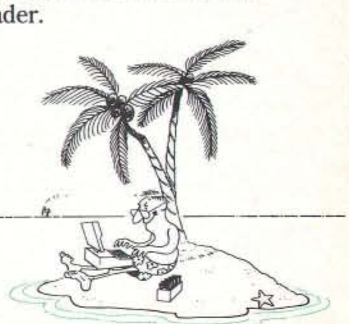
Code linked with Plink86+ automatically uses expanded or extended memory. No modifications to your source is required. If the memory is present your software runs faster; if not it overlays from disk as usual.

Source code necessary to customize prompts and messages for the overlay loader is included. Sage does not require a royalty for products including the overlay loader.

	List	Ours
Professional PVCS, MS-DOS	$495	$419
Professional PVCS, OS/2	$595	$505
Demo II	$199	$159
Plink86+	$495	$395

1-800-445-7899

Programmer's Paradise



Programmer's Paradise... for

CAN I PAY YOU IN BEADS?... NO! COCONUTS?... NO! AMERICAN EXPRESS... GREAT!
COCONUTS? HE'S OFF HIS COCONUTS!
SORRY, NO BEADS OR COCONUTS, BUT WE ACCEPT ALL MAJOR CREDIT CARDS AS WELL AS COMPANY CHECKS & P.O.'s FROM QUALIFYING ORGANIZATIONS.

WE'LL MATCH NATIONALLY ADVERTISED PRICES.

386 CONTROL PROGRAMS

	LIST	OURS
DESQview 386	190	169
Microsoft Windows/386	**195**	129
VM/386	245	199
VM/386 Multi-User	895	819
VM/386 NetPak	150	119

386 DEVELOPMENT TOOLS

	LIST	OURS
386 ASM/LINK	495	435
Lahey F77L-EM/32 (w/ OS/386)	1090	975
Novell C Network Compiler/386	995	779
Paradox/386	895	629
WATCOM C 7.0/386	895	799

ASSEMBLY LANGUAGE

	LIST	OURS
Advantage Disassembler	295	279
ASMFlow	99	89
ASMTool	90	80
MS Macro Assembler	**150**	95
OPTASM	125	109
Re:Source	150	129
Sourcer w/ Pre-Processor	140	125
Turbo Assembler/Debugger	150	105
Visible Computer: 80286	100	89

BASIC COMPILERS

	LIST	OURS
MS BASIC Prof. Devel. System	**495**	329
QuickBASIC	99	69
True BASIC	100	69
Turbo Basic	100	69

BASIC LIBS/UTILITIES

	LIST	OURS
db/LIB	139	121
DiaLogic	79	70
GraphPak	79	70
GraphPak Professional	149	125
LaserPak	79	70
P.D.Q.	99	89
ProBas	135	125
ProBas HyperHelp Toolkit	99	94
ProBas Telecomm. Toolkit	75	70
ProBas Toolkit	99	94
ProMath	99	94
ProScreen	99	89
QBase and Quickscreen	149	125
QuickComm	139	125
QuickMenu	59	55
QuickPak	79	70
QuickPak Professional	149	125
QuickPak Scientific	79	70
QuickScreen	79	70
QuickWindows Advanced	149	125
QuickWindows Advanced Corp.	500	445

C COMPILERS

	LIST	OURS
C Network Compiler	695	525
Lattice C 6.0	250	155
Microsoft C	**450**	289
MS QuickC	**99**	65
MS QuickC w/ QuickAssembler	199	135
Top Speed C	199	179
DOS Professional	399	359
OS/2 Professional	495	445
Turbo C	150	99
Turbo C Professional	250	169
WATCOM C 7.0	395	319

C++

	LIST	OURS
Guidelines C++	295	269
NDP C++	495	479
Zortech C++	200	165
Developer's Edition	450	385
Zortech C++ Tools	150	129
Zortech C++ Video Course	500	449

C-COMMUNICATIONS

	LIST	OURS
Breakout II	125	99
C Asynch Manager 3.0	189	139
Essential Communications	329	259
Greenleaf Comm. Library	299	215
Greenleaf ViewComm	559	475
SilverComm C Async Library	249	209
View-232	189	CALL

C-FILE MANAGEMENT

	LIST	OURS
Btrieve	245	185
Btrieve for DOS 3.1 Networks	595	449
CBTREE	159	135
C-Index	99	89
C-ISAM	225	209
Codebase IV	295	219
CQL w/ PASS	395	349
c-tree	395	315
dBC III	250	219
dBC III Plus	500	439
db_FILE Bundle	295	249
Essential B-Tree w/ source	199	149
FairCom Toolbox - Prof. Edition	1095	789
FairCom Toolbox - Special	695	509
Informix Products	CALL	CALL
Xtrieve PLUS	595	459

C-GENERAL LIBRARIES

	LIST	OURS
C TOOLS PLUS/6.0	149	109
C Utility Library	249	175
Greenleaf Functions	229	159
Greenleaf SuperFunctions	299	209
Power Search	149	99
Turbo C TOOLS/2.0	149	109

C SCREENS

	LIST	OURS
C-Worthy w/ forms and source	495	CALL
FaceIt	99	89
Greenleaf DataWindows	395	309
Hi-Screen XL	149	129
Hi-Screen XL Prof. Series	325	275
JAM	595	529
Panel Plus	495	395
Power Screen	149	109
Vermont Views	395	319
Vitamin C	225	165
VC Screen	149	115

C-UTILITIES/OTHER

	LIST	OURS
Clear +	200	169
C-Terp	300	219
Heap Expander	80	70
Norton Guides for C	100	65
PC-lint	139	109
PCYACC Personal	249	125
PCYACC Professional	495	359
TimeSlicer	295	279
w/ source	1000	899

COBOL LANGUAGE

	LIST	OURS
Micro Focus:		
COBOL/2 w/ Toolset	1800	1499
Personal COBOL	149	129
MS COBOL	900	629
Realia COBOL	995	849
w/ RealMENU	1145	979
SCREENIO	400	375

CODE GENERATORS

	LIST	OURS
C Source	395	299
Logic Gem	99	89
Matrix Layout 3.0	200	169
PRO-C	399	339

DATABASE DEVELOPMENT

	LIST	OURS
Clarion 2.0	695	499
Clipper 5.0	695	519
dBASE IV	795	489
dBFast/PLUS	249	219
dGE	195	179
FlashTools!	89	79
FoxBASE+	395	249
Magic PC	299	249
R&R Report Writer	150	129
R&R Code Generator	150	129
Say What?!	50	45
SilverComm Library 2.0	189	165
Tom Rettig's Library	100	80

DOCUMENTING/ FLOWCHARTING

	LIST	OURS
Clear+	200	169
C-Clearly	130	115
Flow Charting II+	229	185
Interactive Easyflow	150	125
Paginate	100	90
Source Print	99	89
The Documentor	295	245
Tree Diagrammer	99	89

EDITORS

	LIST	OURS
BRIEF 3.0	199	CALL
Edix	195	165
EMACS	325	265
Epsilon	195	138
KEDIT 4.0	150	125
MKS Vi	149	129
Multi-Edit	99	89
Multi-Edit Professional	179	159
Norton Editor	75	59
SLICK Editor	195	175
SPF/PC	245	199
VEDIT PLUS	185	115
Vq²	150	135

FORTRAN LANGUAGE

	LIST	OURS
Grafmatic	135	119
Lahey F77L	595	529
Lahey Personal FORTRAN 77	95	89
MS FORTRAN	**450**	289
Plotmatic	135	119
RM/FORTRAN	595	499

GRAPHICS LIBRARIES

	LIST	OURS
Baby Driver	250	199
Essential Graphics	399	279
Font-Tools	150	119
Font Window	125	109
GraphiC 5.0	395	319
Graphics-MENU	195	175
Data Entry Design	99	89
Data Entry Module	59	53
GSS Graphics Devel. Toolkit	595	509
HALO	395	279
HALO Window Toolkit	595	419
Icon-Tools/Plus	150	119
Menuet	250	199
MetaWindow	250	209
MetaWindow Plus	325	269
PCX Effects	99	89
PCX Programmer's Toolkit	195	175
PCX Text	149	135
Turbo Geometry Library	200	179

LINKERS/LIBRARIANS

	LIST	OURS
Plink86plus	495	395
PolyLibrarian II	149	135
.RTLink	295	265
.RTLink/Plus	495	CALL

MODULA-2

	LIST	OURS
LOGITECH Modula-2:		
Compiler Pack	99	75
Development System	249	199
TopSpeed Modula-2:		
B-Tree Toolkit	149	135
Communications Toolkit	149	135
Compiler Kit	100	89
DOS 3-Pack	200	179

NETWORK PROGRAMMING

	LIST	OURS
Btrieve/N	595	459
Novell C Network Compiler	695	559
dBASE IV LAN Pack	995	645
FoxBASE +/ LAN	595	479
NetWare C Interface	295	239
NetWare SQL	595	459
Paradox LAN Pack	995	697
Remote Procedure Calls	950	829

OS/2 TOOLS

	LIST	OURS
Brief	199	155
Btrieve	595	449
CASE:PM	995	949
Epsilon	195	159
Greenleaf DataWindows	395	330
MKS LEX:YACC (OS/2)	399	339
MKS Toolkit (DOS & OS/2)	399	339
MS OS/2 Pres. Mgr. Softset	150	105
MS OS/2 Pres. Mgr. Toolkit	**500**	339
MultiScope	299	229
Panel Plus	495	395
PC-lint	139	101
PCYACC	395	359
Smalltalk/V PM	495	395
Vitamin C (OS/2)	225	165
XVT/PM	595	509

PASCAL LANGUAGE

	LIST	OURS
Asynch PLUS	149	115
B-tree Filer	125	99
MS QuickPASCAL	99	69
Object Professional	150	119
Power Tools PLUS/5.0	149	109
Topaz	75	67
Turbo Analyst	99	79
TurboMAGIC	199	179
Turbo Pascal 5.5	150	105
Turbo Pascal 5.5 Professional	250	175
Turbo-Plus 5.5	199	159
Turbo Professional 5.0	125	99

PROTOTYPING

	LIST	OURS
Dan Bricklin's Demo II	195	159
Instant Replay III	150	135
ProtoFinish	300	269
Show Partner F/X	350	319
Soft Demo	80	70

TRANSLATORS

	LIST	OURS
Bas_C Commercial	375	323
dBx Translator	550	467
FOR_C	575	519
PROMULA.FORTRAN	450	399

WINDOWS (MS) TOOLS

	LIST	OURS
Actor	495	395
Case:W	795	759
C-Talk/Views	450	375
dBFast/Windows	249	229
MS Windows Development Kit	500	349
RFFlow	79	69
Whitewater Resource Toolkit	195	169
WinTrieve	395	339

ADDITIONAL LANGUAGES

	LIST	OURS
APL*PLUS	695	549
Janus Ada/Compiler System	300	269
Lattice RPG	1600	1469
Meridian AdaStudent	50	45
Meridian Ada Developer's Kit	1095	985
MKS AWK	99	85
Personal Rexx	150	139
PolyAWK	99	85
Smalltalk-80 (386)	595	535
Smalltalk/V	100	85
Smalltalk/V 286	200	169

NEW RELEASES

ProtoFinish ***by Genesis***

ProtoFinish creates program prototypes, demos and tutorials. Screen design module for ASCII-based screens. Screen capture utility. 4th-generation language for simulating look and feel of program. Run-time utility. Assembly language routines for incorporating screens in C, PASCAL, BASIC, and Clipper code.

List: $300 **Ours: $269**

C-Clearly ***by V Communications***

C source code formatter, ideal for making obtuse code clear. Allows all of your code to be presented in a consistent format of your choosing. Templates are included for several common styles as well as standard K & R.

List: $130 **Ours: $115**

Help/Build ***by Pacific Firmware***

Help/Build is a complete help information and error screen generation tool. It allows you to develop any kind of pop-up help and error message system. Programmers and technical writers use it to create context-sensitive, truly user-friendly help for both novice and expert.

List: $249 **Ours: $179**

Service, Selection, $avings *(800) 445-7899*

Input Devices

	List	Ours
FastTRAP Serial	119	99
FastTRAP Bus	139	119
PC-TRAC Serial	149	125
PC-TRAC Bus	169	143
PC-TRAC PS/2	119	99
Logitech Series 9 Bus Mouse	129	85
for PS/2	109	69
Logitech Ser. 9 Serial Mouse	119	79
for PS/2	139	89
MS Mouse w/ Wndws, Ptbrsh	150	109
MS Mouse w/ Paintbrush	200	139
ScanMan Plus	339	199

APPLICATION SOFTWARE

COMMUNICATIONS

	LIST	OURS
Carbon Copy Plus	199	129
Laplink III	150	99
PC Anywhere III	145	99
Procomm Plus	75	50
SideTalk	120	90

DESKTOP PUBLISHING

	LIST	OURS
Adobe Illustrator	695	409
Corel Draw!	595	399
Gem Desktop Publisher	299	183
HALO DPE	195	139
Lattice HighStyle	375	319
MKS SQPS	495	479
PageMaker	795	509
Ventura Publisher	895	525

MATHEMATICS

	LIST	OURS
Derive	200	179
MathCAD	495	315
Mathematica 386	695	625

SCIENCE & ENGINEERING

	LIST	OURS
AutoCAD Release 10	3000	CALL
AutoSketch	150	95
ChiWriter	150	129
Control System Toolbox	495	375
CSS	495	469
Design CAD 3-D	400	292
Drafix Windows CAD	695	CALL
EXACT	475	380
Generic CADD Level 3	300	179
LABTECH Acquire	195	179
LABTECH Chrom	995	779
LABTECH Notebook	995	779
MICRO-CAP III	1495	1269
Orcad PCB	1495	CALL
PC TEX	249	229
SCHEMA II+	495	449
STATGRAPHICS	895	586
Tango CAD Pack	995	949
Tango PCB Series II	595	559
TECH*GRAPH*PAD	395	319
T^3	595	479

UTILITIES

	LIST	OURS
386 MAX	75	66
386 MAX Professional	129	115
above DISC	100	84
Command Plus	130	109
FASTBACK Plus	189	109
Help Build	250	179
MACE GOLD	149	129
Magellan	139	99
Memory Mate	70	47
MKS Toolkit	249	199
Move'em	89	79
Norton Commander	89	58
Norton Utilities	100	65
Norton Utilities Advanced	150	99
PC/Tools Deluxe	129	80
Pizazz Plus	149	79
QEMM/386	60	55
SpinRite	89	69
XTreePro	129	109

PRODUCTS BY VENDOR

BORLAND

	LIST	OURS
Paradox 3.0	725	509
SideKick Plus	200	139
Turbo Assembler/Debugger	150	105
Turbo C 2.0	150	99
Turbo C 2.0 Professional	250	169
Turbo Pascal 5.5	150	105
Turbo Pascal 5.5 Professional	250	175

DIGITALK

	LIST	OURS
Smalltalk/V	100	85
Communications	50	45
EGA/VGA Color Extension	50	45
Goodies #1, #2 or #3	50	45
Smalltalk/V 286	200	169
Smalltalk/V PM	495	395

IGC

	LIST	OURS
VM/386	245	199
VM/386 Multi-User	895	819
VM/386 NetPak	150	119

MEDIA CYBERNETICS

	LIST	OURS
Dr. HALO III	140	99
HALO DPE	195	139
HALO	395	279
HALO for OS/2	695	489
HALOvision III	495	349
HALO Window Toolkit	595	419
HALO for MS Developers	595	419

MICROSOFT

	LIST	OURS
MS BASIC Prof. Devel. System	**495**	329
MS C	**450**	289
MS COBOL	900	629
MS FORTRAN	**450**	289
MS Macro Assembler	**150**	95
MS OS/2 Present. Mgr. Toolkit	**500**	339
MS OS/2 Softset	150	105
MS Pascal	300	209
MS Programmer's Library	395	275
MS QuickBASIC 4.5	99	69
MS QuickC 2.0	**99**	65
MS QuickC w/ QuickAssembler	199	135
MS QuickPASCAL	99	69
MS Windows	99	69
MS Windows/386	**195**	129
MS Windows Development Kit	500	349

PERISCOPE

	LIST	OURS
Periscope I	495	429
Periscope I/512K	595	509
Periscope I/MCA	745	639
Periscope II	175	125
Periscope II-x	145	105
Periscope III/10 MHz	1395	1059
Periscope IV/25 MHz	2595	2195

POLYTRON

	LIST	OURS
Dan Bricklin's Demo II Program	199	159
Personal PVCS	149	125
Plink86+	495	395
PolyAWK	99	85
PolyDoc	199	169
PolyMake	149	125
PolyShell	99	85
Professional PVCS	495	419

SOUTH MOUNTAIN SOFTWARE

	LIST	OURS
Breakout II	125	99
C Utility Library	199	159
Essential B-Tree	99	79
w/ source	198	159
Essential Communications	249	199
Essential Graphics	299	239
w/ source	598	479
GUIDO	CALL	CALL
Hold Everything	129	109
/*resident C*/	99	79
w/ source	198	159
Screen Star	99	79
w/ source	198	159

WHITEWATER GROUP

	LIST	OURS
Actor	495	395
Language Extensions I	99	85
Whitewater Resource Toolkit	195	169
WinTrieve	395	339

Programmer's Policies

Phone Orders
Hours 9 AM-7 PM EST. We accept MasterCard, Visa, American Express. Include $4.00 per item for shipping and handling. All domestic shipments by UPS ground. Rush service available.

Mail Orders
POs by mail or fax are welcome. Please include phone number.

International Service
Phone number required with order. Call or fax for additional information.

Dealers and Corporate Accounts
Call for information.

Unbeatable Prices
We'll match nationally advertised prices. (Subject to same terms and conditions.)

Return Policy
30-day no-hassle return policy. Most manufacturer's products cannot be returned once disk seals are broken.

ACTOR 2.0--New Version--More Memory

Actor® 2.0 is a significantly enhanced version of Actor, the most productive way to write programs for Microsoft Windows. ***Actor*** is an interactive, object-oriented programming system, featuring a large class library and source-code debugging. Since its release in 1987, ***Actor*** has enabled thousands of developers to learn object-oriented programming while creating MS-Windows applications in half the time it takes in C. This new version breaks the 640K barrier with automatic memory swapping. It also includes support for user-defined primitives, as well as advanced object-oriented programming features.

List: $495 Ours: $395

The Whitewater Group®

Dr. Switch™

Run ***Dr. Switch*** from a program's Exit-to-DOS feature and swap all but 4k of it out of memory. Use ***Dr. Switch*** with MS Make or PolyMake to give your compiler, linker and version control system an additional 100K of RAM to work with.

Dr. Switch allows you to swap RAM resident programs such as desktop utilities and help guides out of the way while you compile, link and test your programs. The Doctor uses only 4k! And it can take full advantage of any expanded or extended memory you have available.

List: $99 Ours: $85

Black & White International, Inc.

MS Basic Prof. Development System

A complete solution for serious professional BASIC programmers. This system allows you to create large programs with up to 16 MB of compiled code. And speed optimizations and more granular run-time libraries mean smaller and faster executables. **Microsoft BASIC** includes many new language features including a completely integrated ISAM for creating fast, powerful database applications. Expect productivity gains using the **MS QuickBASIC** extended environment. Full EMS support allows you to handle larger programs than with QuickBASIC and the integrated debugger has twice the capacity. There's more, in fact everything you'll probably need in one package.

List: $495 Ours: ~~$349~~ $329

Microsoft®

HALO Window Toolkit: The Windowing Alternative

The HALO Window Toolkit is a graphical user interface tool that speeds development of graphics and imaging applications.

MEDIA CYBERNETICS

- Extensive memory management facility detects and uses internal, extended, expanded and disk memory as needed
- Includes HALO graphics toolkit
- Supports wide variety of graphics displays (including high resolution), imaging devices, printers and scanners
- Practical time-saver for Microsoft C Programmers
- Provides a source code compatible development path to target both the DOS and OS/2 operating environments

List: $595 Ours: $419

International: **201-389-9228**
Customer Service: **201-389-9229**
Fax: **201-389-9227**

New Corporate Phone #:
800-422-6507

Call or Write for Latest Free Catalog!

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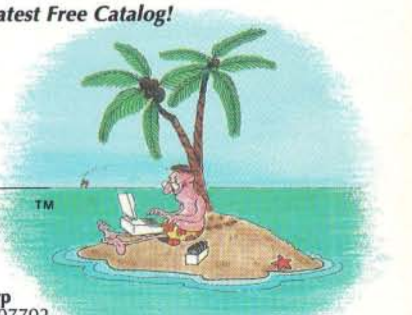
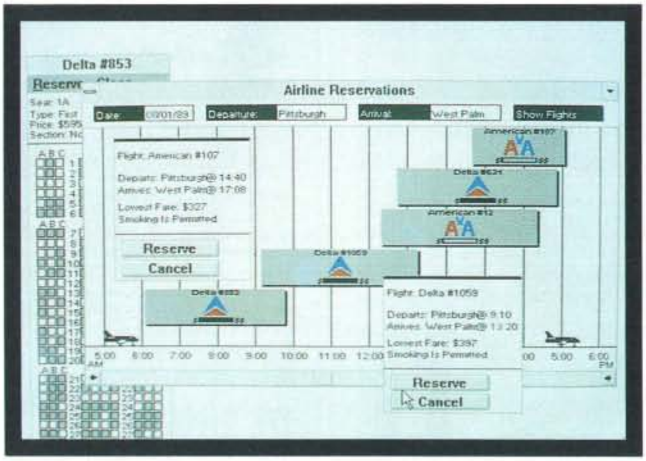
Programmer's Paradise™



A Division of Voyager Software Corp
1163 Shrewsbury Ave., Shrewsbury, NJ 07702

Circle 223 on Reader Service Card



Flight: American #107
Departs: Pittsburgh@ 14:40
Arrives: West Palm@ 17:08
Lowest Fare: $327
Smoking Is Permitted

Flight: Delta #1059
Departs: Pittsburgh@ 9:10
Arrives: West Palm@ 13:20
Lowest Fare: $397
Smoking Is Permitted

With Choreographer's display editor, you can create interface elements that appear inside the client area of the application (in this case, the icons that can display flight information).

Add PM or Windows Interfaces to Applications

With Choreographer, you can design a custom interface for your application running under Windows or OS/2's Presentation Manager. According to GUIdance Technologies, the interface you create can compile into a dynamic-link-library or executable file. An application can drive the interface, or vice versa.

According to GUIdance, you can call C code from within Choreographer or call Choreographer from C code using an Application Programmer Interface. And you aren't required to run everything from Choreographer: When you compile the application, the development environment can drop out; what's left is an object module that's linkable, similar to something you'd produce with a C compiler.

Choreographer includes display and bit-map editors, class and instance browsers, an object inspector, an interactive debugger, a thread manager, an interface object library, and a display editor.

GUIdance says that you can use Choreographer to build graphical user interfaces for Unix Motif, LAN Manager, Logical Unit 2 and 6.2, and Structured Query Language.
Price: $2995 to $7500.
Contact: GUIdance Technologies, Inc., 800 Vinial St., Suite 412, Pittsburgh, PA 15212, (412) 231-1300.
Inquiry 1155.

Protected-Mode C Compiler

A new version of Rational Systems' Instant-C incremental compiler uses the company's DOS extender technology to let you compile and run protected-mode versions of C applications that can support up to 16 megabytes of memory. The Instant-C 4.0 environment runs exclusively in protected mode, but you can use the compiler's Mixed Mode feature to run the application in real mode, allowing you to run larger programs. Mixed Mode also lets you compile an application without having to worry about the restrictions on assembly and object code that protected mode imposes.

Instant-C 4.0 includes a code browser, data inspection windows, dynamic cross-referencing for functions or data, and automatic generation of function prototypes. The compiler runs on the IBM AT with 1 megabyte of RAM.
Price: $795.
Contact: Rational Systems, Inc., 220 North Main St., Second Floor, P.O. Box 480, Natick, MA 01760, (508) 653-6006.
Inquiry 1157.

CASE:PM Opens Up to COBOL and C

The programming toolkit CASE:PM, which is designed to simplify the often-frustrating job of creating Presentation Manager (PM) applications, now comes in a version that lets you develop OS/2 applications in COBOL.

With CASE:PM for COBOL (used along with the OS/2 1.2 Software Development Kit), you can develop new Systems Application Architecture–compliant applications or modify existing COBOL code for use under OS/2.

Caseworks has opened up the internal knowledge base on both the C and the COBOL versions of CASE:PM. This lets you customize CASE:PM's proprietary internal Software Engineering Language to incorporate your own common instructions, rules, and procedures. Caseworks says that this is useful for programming teams, where incorporating standard routines such as communications or disk I/O into the SEL knowledge base eliminates the need for rewriting commonly used code.

Also added to the newest versions of CASE:PM is the ability to switch between a "build" view (for constructing PM screens) and a "test" view that lets you test your work (as though it were a running PM application) before generating and compiling code.

CASE:PM now supports multiple, overlapped, and tiled child windows. Also included is a code management facility that automatically brings forward programmer-added code each time you change or redesign the interface.
Price: CASE:PM for C: closed knowledge base, $1995; open knowledge base, $3995; CASE:PM for COBOL: closed knowledge base, $2495; open knowledge base, $4495.
Contact: Caseworks, Inc., 1 Dunwoody Park, Suite 130, Atlanta, GA 30338, (404) 399-6236.
Inquiry 1158.

Design DSP Applications on the Mac

DSP Designer 1.0 from Zola Technologies is an integrated design environment for the development of digital signal processing applications for the Motorola 56001 processor.

The program uses the extensible environment of MPW 3.0 to develop and test digital filters, create test signals, and generate filter code. You can also perform real-time evaluations of DSP56001 programs running on a Digidesign Sound Accelerator card.

DSP Designer 1.0 runs on the Mac Plus or higher with at least 1 megabyte of memory (2 to 4 megabytes is recommended).
Price: $895; with MPW 3.0, $995.
Contact: Zola Technologies, Inc., 6195 Heards Creek Dr. NW, Suite 201, Atlanta, GA 30328, (404) 843-2972.
Inquiry 1156.

continued

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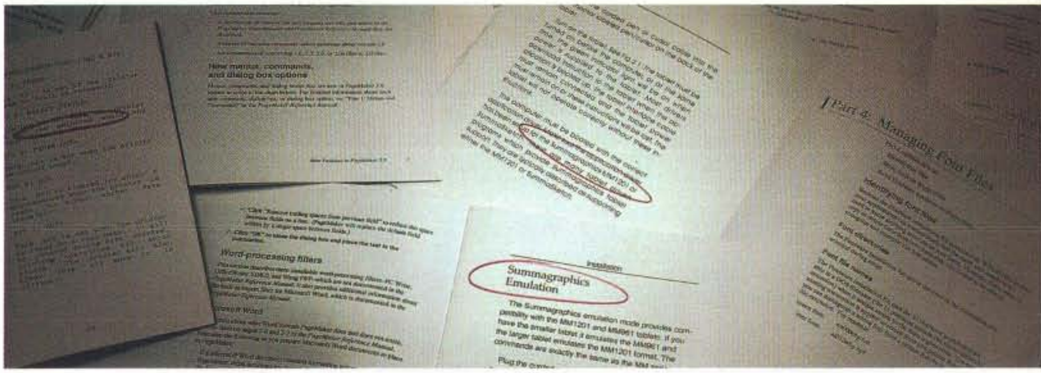

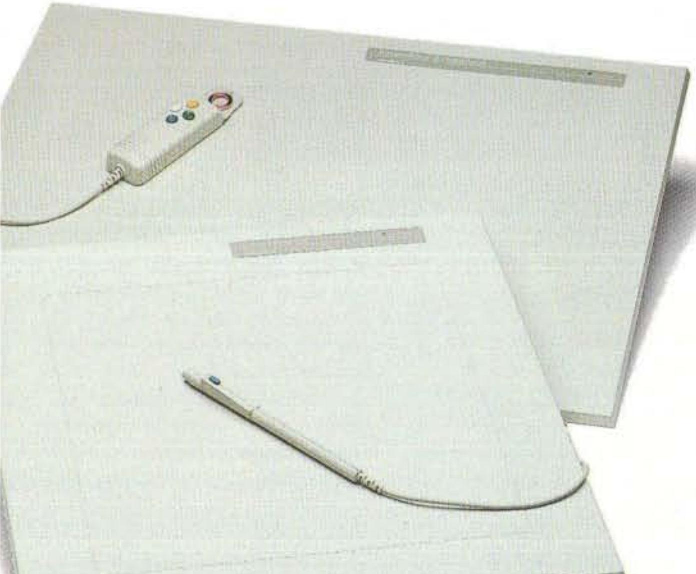

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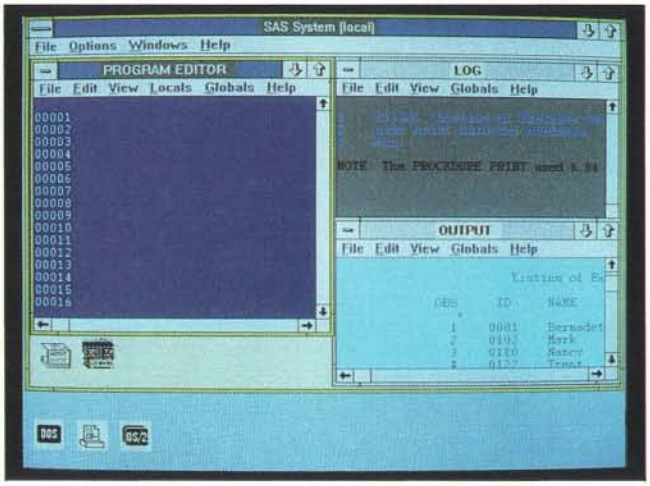
For IBM/Compatible information circle 272, for Macintosh information circle 273, for Dealer inquiries circle 274 on Reader Service Card.

SAS Coming for OS/2

SAS Institute is developing a version of its SAS System integrated software to run under the OS/2 Presentation Manager. The program will feature data management, statistical analysis, report writing, graphics, decision support, and applications development, while taking advantage of all OS/2 PM features.

The program, which should be available in the second quarter of this year, will run on the IBM AT with OS/2 1.1, a hard disk drive, and 6 megabytes of RAM.
Price: $695 for a one-year single-workstation license; $330 for renewal; quantity discounts are available.
Contact: SAS Institute, Inc., SAS Circle, Box 8000, Cary, NC 27512, (919) 467-8000.
Inquiry 1160.



The SAS program editor, log, and output. In the editor, you can tell SAS where to find your data, what data to analyze, and which application to invoke (here, an employee database).

Develop Realistic Plans with ProjectBASE

ProjectBASE, a front-end tool for scheduling and tracking packages, helps you compose project plans and cost estimates. It consists of four modules: Lifecycle, Planning, Estimating, and Customizer.

ProjectBASE now includes a form-generation utility that will generate a prompt list for the project manager. With the list you can cross-reference tasks and deliverables and determine what is needed to complete each task.

As you select tasks from the Lifecycle module, the Planning module automatically computes a potential Program Evaluation Resource Technique diagram that displays task dependencies. Once you've created a plan, the Estimating module helps you predict the cost and effort needed to complete the project using the historic database. When estimating, the program considers factors such as each employee's experience, knowledge, and predicted percentage of time available for work on the project.

You can then export the estimates to a program such as SuperProject, ViewPoint, or Project WorkBench. ProjectBASE runs on the IBM PC with a hard disk drive.
Price: $2950 for all four modules.
Contact: Center for Project Management, 18 Crow Canyon Court, Suite 290, San Ramon, CA 94583, (415) 837-0397.
Inquiry 1166.

Link Files Under the Toccata Umbrella

Toccata is a Structured Query Language–based database repository that runs under Microsoft Windows and lets you integrate dBASE, Lotus 1-2-3, flat, and other file formats into a common platform. You don't have to transfer or restructure data, and because it runs under Windows, Toccata lets you build applications without seeing the command-line interface.

With Toccata's six application processors, you can create applications that perform such operations as joining a Lotus 1-2-3 worksheet with a dBASE table or aggregating a hierarchical file to the 1-2-3 format.

Toccata runs on the IBM AT with 512K bytes of RAM.
Price: $495.
Contact: Business Planning Systems, Inc., P.O. Box 725, Carlisle, MA 01741, (508) 369-2574.
Inquiry 1161.

A Contact Management Program

The newest version of Maximizer, a contact management program, lets you set up client lists with up to 10 different columns, allowing one primary and up to nine secondary sorts.

Richmond has revamped the program's editor to support boldfacing, underlining, italics, centering, justification, page breaks, and other editing functions. You can insert client and contact names into letters, notes, or diaries via Maximizer's paste buffer.

In the day-at-a-glance portion of the program, you can add, move, print, or delete groups of appointments. You can now define, name, and store macro commands.

Maximizer 2.0 works on the IBM PC with a hard disk drive.
Price: $295; network version, $695.
Contact: Richmond Technologies and Software, Inc., 420-6400 Roberts St., Burnaby, BC, Canada V5G 4C9, (800) 663-2030 or (604) 299-2121.
Inquiry 1164.

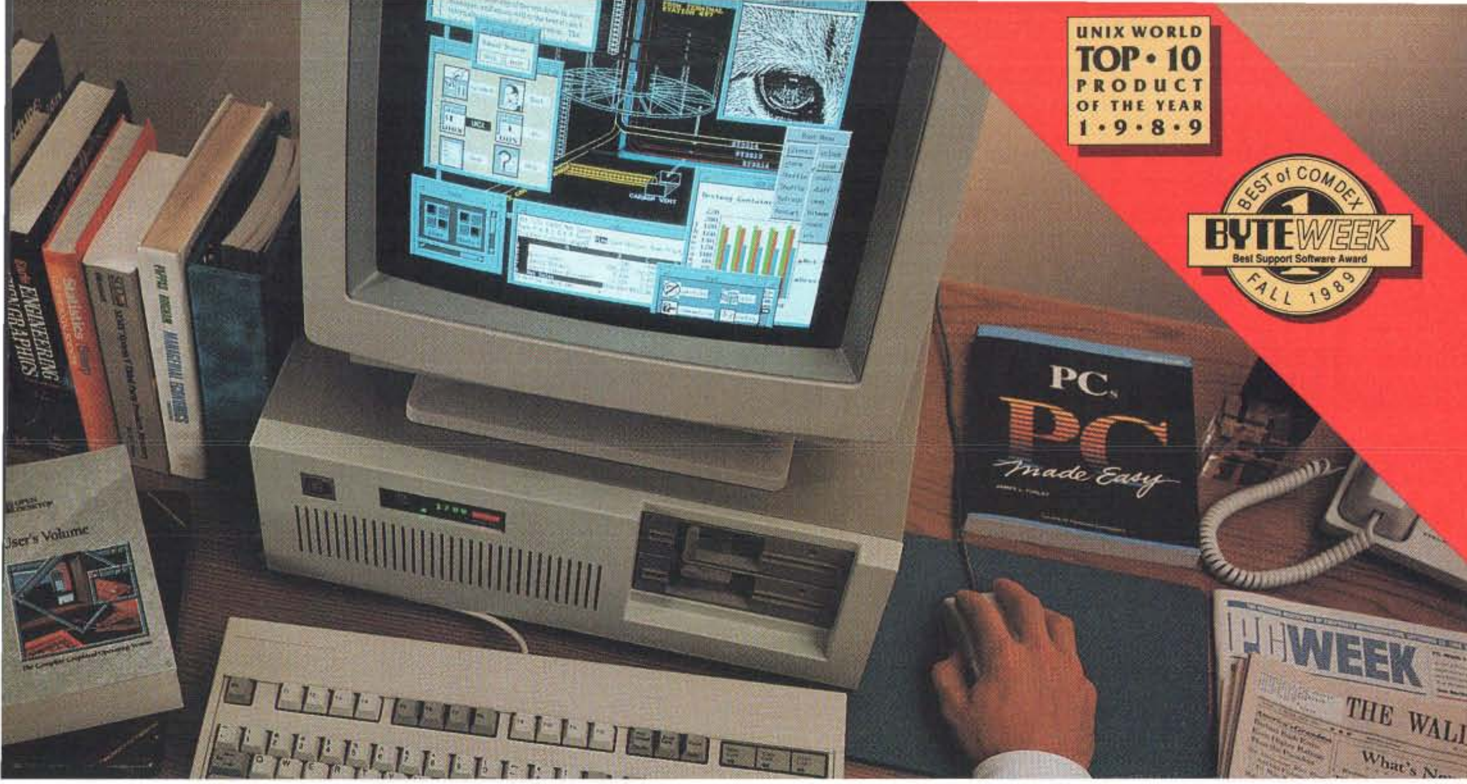
Form Design Under Windows

FormMaster runs under Windows 2.0 and lets you create typeset-quality forms in WYSIWYG format and scale, move, delete, or copy each of the objects that make up the form.

You can use FormMaster to print blank forms, or you can type data into the form and print the form and data together. The program can import and export dBASE III Plus and ASCII data files and handle text, numeric, and formula data field types.

FormMaster lets you save data entered into a form as a separate record. You can jump among data records and print forms with selected records. You'll need 640K bytes of RAM to run the program.
Price: $395.
Contact: Information Integration, Inc., 901 Russell Ave., Gaithersburg, MD 20879, (301) 840-8977.
Inquiry 1162.

continued



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You must disclose your marital status.
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☐ legally separated

A married person may apply for individual credit. I am applying for (please check appropriate box):

☐ **JOINT CREDIT** with another person. Complete entire application.
☐ **INDIVIDUAL CREDIT** but rely on income or assets of another person as a basis for repaying the credit requested. Complete entire application.
☐ **INDIVIDUAL CREDIT.** Complete sections "a" and "b" only.

Please complete all appropriate sections, providing at least two year's residence and employment history. This will enable your application to be processed as quickly as possible. If you are self-employed, please be sure to complete section "D" on back.

Applicants must be 18 years of age or older.

a. Your Personal Information

Requested Line of Credit $

Your Name: First Initial Last **Date of Birth:** Mo. Day Yr. **Social Security Number:**
Present Address Street Apt. # City State Zip **Home Phone** ( ) –
Date of Residence: Month Year **Monthly Payment: $** Buy ☐ Rent ☐ Other ☐
Previous Address: **Dates of Residence:** From To
Your Employer: (If self-employed, see rear panel) **Date of Employment:** Mo. Yr. **Position:** **Monthly Income:** Gross $ Net $
Employer's Address: Street City State **Business Phone:** ( ) –
Previous Employer: **Address:** **Dates of Employment:** From To

Income from alimony, child support or separate maintenance payments need not be disclosed if you do not wish to have it considered as a basis for repaying this obligation.

Other Income:
I have received since: (Date) Monthly Income: Gross $ Net $

Name and Address of Nearest Relative Not Living With You: Relationship:

b. Credit Information

Include joint applicant's information, if joint account requested.

Bank Account: Bank Name Address ☐ Checking ☐ Savings
Bank Account: ☐ Checking ☐ Savings

	Payment	Balance
Bank Loan Reference:		
Bank Card Reference: ☐ **VISA** ☐ **MasterCard**		
Other Credit Card Reference		
Other Credit References: Account No: Expires:		

Driver's License No. State: Expires:

c. Joint Applicant's Personal Information

*If you are a married Wisconsin applicant, you must provide your spouse's information below, even though your spouse may not be signing this contract.

Joint Applicant's Name: First Initial Last **Date of Birth:** Mo. Day Yr. **Social Security Number:**
Address Street Apt. # City State Zip **Date of Residence:** Mo. Yr. **Home Phone** ( ) –
Employer: **Date of Employment:** Mo. Yr. **Position:** **Monthly Income:** Gross $ Net $
Employer's Address: Street City State **Business Phone:** ( ) –

d. Self-Employed Information

Complete this section only if you are self-employed.

Business Name: ☐ Proprietorship ☐ Corporation ☐ Partnership
Business Address: Business Telephone: ( ) –
Description of Business: Your Position: In Business Since:
Your annual income from business: Business' annual income: (gross) (net)

You must provide at least one of the following:

1. Business Bank: Name Telephone ( ) – Personal Banker's Name:
2. Accountant's Name Telephone ( ) –
3. **Financial statement on business attached.**

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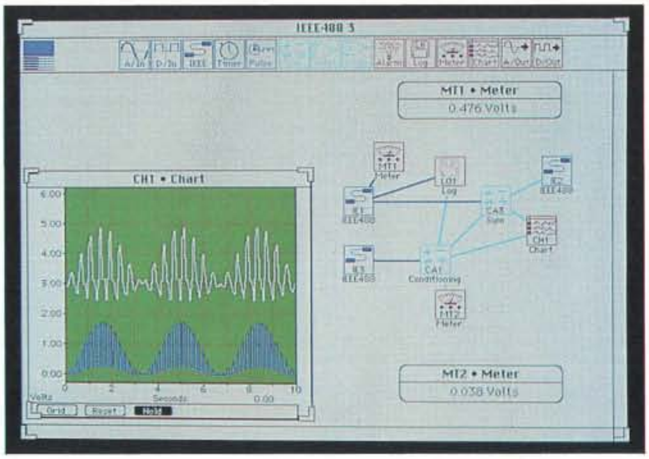
Analog Connection WorkBench for the PC

Strawberry Tree, a company that develops data acquisition products for the Macintosh and IBM PC, has released a PC version of its Analog Connection WorkBench program. Like the Macintosh version, WorkBench PC lets you set up and execute data acquisition applications by dragging icons and connecting wires on the screen to program, measure, and control analog and digital I/O without writing a single line of programming code. The company has also changed the name of the Analog Connection WorkBench 3.0 to WorkBench Mac.

In both versions, WorkBench has 14 icons (e.g., calculation, meter, chart, IEEE 488, pulse, and average) that you pull down and connect with wires to create a symbolic representation of what will actually happen in the hardware. Once the connections are made, you see the results immediately.

The program's fast mode supports data acquisition as fast as the hardware will allow. Strawberry Tree says the program can handle 80 percent of the data acquisition needs of a laboratory. It supports external functions, allowing you to program through a high-level language if the program doesn't support your required application.

WorkBench Mac requires at least 1 megabyte of RAM and is compatible with Excel and dBASE III. It works on the IBM PC with 640K bytes of RAM and a mouse.
Price: $995 each.
Contact: Strawberry Tree, Inc., 160 South Wolfe Rd., Sunnyvale, CA 94086, (408) 736-8800.
Inquiry 1167.



With either version of WorkBench, data acquisition can be as easy as connecting the dots.

Tools for Electrical Engineers

A new version of DAPPER (Distribution Analysis for Power Planning, Evaluation, and Reporting) can handle transient motor starting analysis, allowing you to predict the effects on an electrical system when a large motor is turned on. DAPPER is a set of programs for the design and analysis of industrial and commercial distribution power systems.

According to SKM Systems Analysis, DAPPER 3.4's Concurrent interface provides a two-way communication channel between it and any CAD program that accepts a DXF transfer file. DAPPER 3.4 produces load schedules and generates automatic one-line diagrams. It can handle feeder and transformer sizing, load flow, and fault studies. It generates reports for three-phase, single line-to-ground, line-to-line, and double line-to-fault duties.

DAPPER 3.4 runs on the IBM XT with 640K bytes of RAM, any graphics adapter, and a hard disk drive.
Price: For 100 nodes, $3950; for 300 nodes, $6395.
Contact: SKM Systems Analysis, Inc., P.O. Box 3376, Manhattan Beach, CA 90266, (800) 232-6789 or (213) 546-6121.
Inquiry 1169.

CircuitSoft is composed of four modules that use decision matrices to automatically apply requirements, limitations, comparisons, and restrictions as defined by manufacturers and the National Electrical Code (NEC). With CircuitSoft, you enter data once and forward it to the correct module. CSMain serves as the main menu program.

The Busses module handles the basic tasks for an electrical design project, including load identification and determining the NEC load types.

Distrib, the load calculation program, calculates the load on each bus, the branch circuit loads, and the downstream loads that are served by that bus. Wirsiz is the module that calculates transformers, overcurrent devices, phase and neutral conductors, busway sizes, conduit, equipment ground wires, and system ground wires.

The Ctrl ^Z module calculates voltage drop, short circuit, and fault let-through of overcurrent protection devices.

CircuitSoft runs on the IBM AT with 640K bytes of RAM and a hard disk drive.
Price: $700 to $1200 per module.
Contact: CHP Computer Services, 1726 Augusta Dr., Suite 118, Houston, TX 77057, (713) 977-3581.
Inquiry 1170.

Graphics and Data Analysis for the PC

Axum combines the capabilities of a business graphing package with statistics, data editing, and curve fitting, according to TriMetrix. After you import data in Lotus 1-2-3, dBASE, or ASCII format, Axum can produce two-dimensional, three-dimensional, and contour plots and charts, including logarithmic axes, three-dimensional mesh and line, and error bar plots.

With the data editor, you can transform, generate, and analyze data. You can perform statistical analyses, curve fitting, and smoothing on data sets as large as your system can handle, the company says. Axum's programming language includes 100 functions and operators. The graph editor lets you add comments, arrows, and symbols; you can combine multiple plots and rotate and reshape three-dimensional objects. More than 20 fonts, including scientific and Russian, are provided.

Axum can generate output for Hewlett-Packard Graphics Language, PostScript, GEM, Lotus PIC, and Tektronix devices. The program runs on the IBM PC with 640K bytes of RAM.
Price: $495.
Contact: TriMetrix, Inc., 444 Northeast Ravenna Blvd., Suite 210, Seattle, WA 98115, (800) 548-5653 or (206) 527-1801.
Inquiry 1168.

continued

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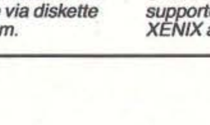
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Manage Duplicate Files with the Phantom Directory

Athena Software's Disc Director lets you visually reorganize your directory structure, eliminate duplicate files, and attach comments of up to 78 characters to programs and directories. The program can also function as a menu system, allowing you to launch programs from data or executable files when you're in a Disc Director session.

Disc Director uses what Athena Software calls a phantom, or virtual, directory to manage duplicate files. The program scans your hard disk for all duplicate filenames. The phantom directory contains a list of pointers to each file. You can manipulate the pointers as if they were actual files in a directory, performing such standard file functions as Copy, Browse, and Erase. The Remove command deletes the filename entry, but not the actual file.

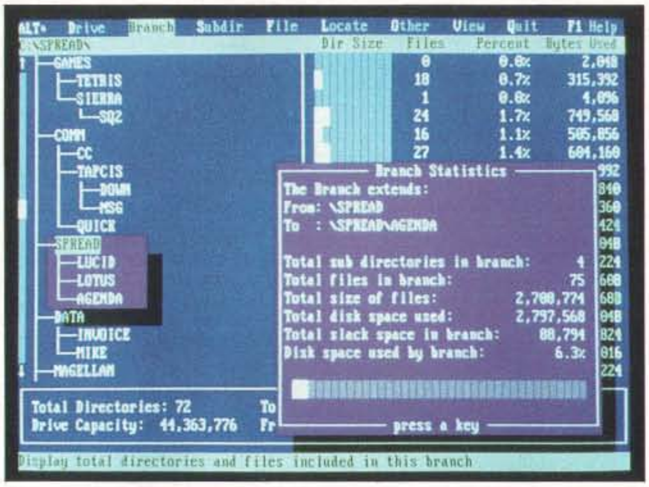
With the program, you can search for a file in eight different ways: by comment, text, attributes, date, duplicate, byte size, filename, and commented files. The program displays information in bar graphs and directory trees. You can rearrange directories by highlighting a "branch" on a tree structure, dragging it to a different location, and then reattaching it.

Disc Director works on the IBM PC with 512K bytes of RAM.

Price: $79.

Contact: Athena Software, 4915 Twin Lakes Rd., Suite 19, Boulder, CO 80301, (303) 666-9569.

Inquiry 1171.



```
C:\SPREAD\                        Dir Size  Files      Percent  Bytes Used
 ├─GAMES                                      0         0.0%       2,048
 │  ├─TETRIS                                 18         0.7%     315,392
 │  └─SIERRA                                  1         0.0%       4,096
 │     └─SQ2                                 24         1.7%     749,568
 ├─COMM                                      16         1.1%     505,856
 │  ├─CC                                     27         1.4%     604,160
 │  ├─TAPCIS          ──────── Branch Statistics ────────────── 992
 │  │  ├─DOWN         The Branch extends:                       840
 │  │  └─MSG          From: \SPREAD                             360
 │  └─QUICK           To  : \SPREAD\AGENDA                      424
 ├─SPREAD                                                       048
 │  ├─LUCID           Total sub directories in branch:       4  224
 │  ├─LOTUS           Total files in branch:                75  608
 │  └─AGENDA          Total size of files:           2,708,774  680
 ├─DATA               Total disk space used:         2,797,568  048
 │  ├─INVOICE         Total slack space in branch:      88,794  824
 │  └─MIKE            Disk space used by branch:          6.3%  816
 └─MAGELLAN                                                     224

 Total Directories: 72         To
 Drive Capacity:  44,363,776   Fr ──────────── press a key ──────────
Display total directories and files included in this branch
```

Disc Director provides information on a branch as you highlight it and then paste it to another section of your hard disk.

Integrated Security Program for the Mac

Casady & Greene's Access Managed Environment (A.M.E.) is a security program for the Macintosh that the company says will prevent unauthorized access and copying and protect your system's hard disk drive.

With A.M.E., you can set access privileges for files, folders, programs, and disks that range from the basic, limited default for first-time users to access that requires a password or key disk. A TouchSafe Accessed Managed Environment (T.A.M.E.) option works with a scanner to check your fingerprint: The scanner checks for blood flow so a photocopy or wax copy of the finger wouldn't fool the system, the company says.

A.M.E. lets you create a hierarchy of users with varying levels of privileges. The program also lets you group files and applications in access sets for identical access privileges, which can simplify the setting and modification of access on systems with many files. An activities log lets you define activities and users to log, filter for viewing specific activities or users, print the filtered log, and limit access to the log. With the log, you can bill clients for computer work.

A.M.E. can encrypt files using fast or DES encryption. You can also set it to erase actual data, not just the filename in the directory, when you delete a file. Another option is multipass erase, designed to meet Department of Defense standards.

Passwords can be case-sensitive, and you can require that users change passwords regularly. And for those quick trips down the hall that turn into extended absences from your desk, you can set A.M.E. to black out the screen so that only authorized users can log on and see your data.

The INIT runs on the Mac Plus or higher and requires about 130K bytes of system memory.

Price: $279; five sites, $895; 10 sites, $1495; T.A.M.E. starts at $3000.

Contact: Casady & Greene, Inc., P.O. Box 223779, Carmel, CA 93922, (408) 624-8716.

Inquiry 1175.

Tempo Macro Utility for Windows

Tempo, the macro utility for the Macintosh that lets you record keystrokes, mouse-clicks, and mouse-drags to automate complex or repetitive tasks, is now available in a version for Microsoft Windows.

Tempo for Windows works within and between applications and supports loop and branch controls for connecting or repeating macros and conditional statements. It can also replay macro commands at varying speeds.

Price: $99.95.

Contact: Affinity Microsystems Ltd., 1050 Walnut St., Suite 425, Boulder, CO 80302, (800) 367-6771 or (303) 442-4840.

Inquiry 1173.

Make Your Spelling Checker More Technical

Geocomp has released a program called TechWords that you can merge with a word processor's spelling checker, allowing it to check for technical terms not commonly found in a spelling checker.

TechWords has vocabulary from computer science; aeronautical, chemical, civil, electrical, industrial, and mechanical engineering; math; bioscience; physics; and space, planetary, and earth sciences. You can choose to integrate just the categories that pertain to your work.

The initial release will support WordPerfect and Microsoft Word for the IBM PC and Macintosh, and XyWrite. Other word processors will be added, Geocomp reports.

Price: $79.

Contact: Geocomp Corp., 66 Commonwealth Ave., Concord, MA 01742, (800) 822-2669 or (508) 369-8304.

Inquiry 1174.

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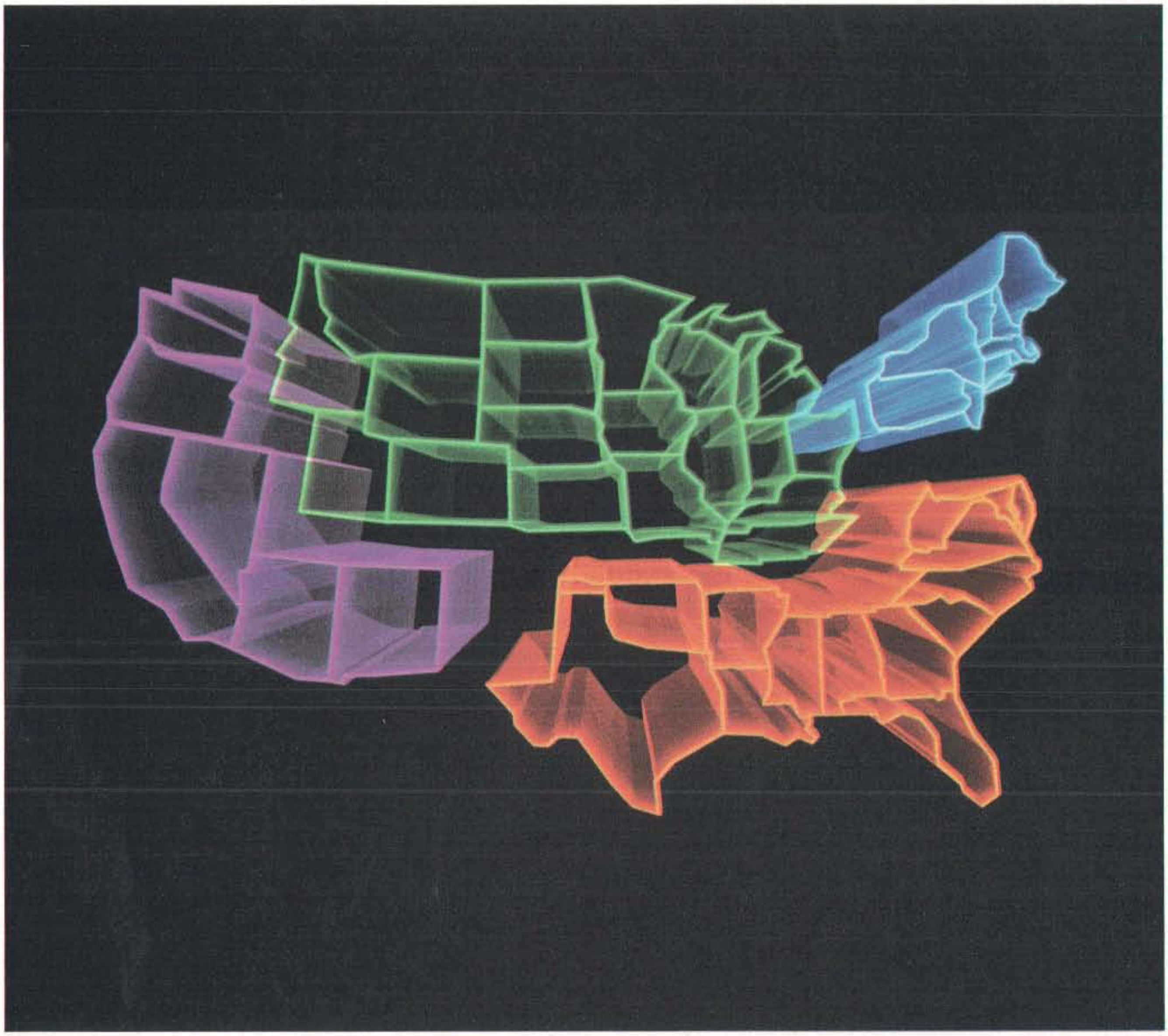

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Finding Needles in Haystacks with CAR

CAD, CASE, and CAM: Many computerists are familiar with these terms, but if you mention CAR, you'll likely draw a blank stare. But due to the efforts of the Missouri Institute for Computer-Assisted Reporting (MICAR), CAR may soon become as well known as CAD, at least to reporters and editors.

Directed by a Pulitzer-prize-winning journalist and self-taught programmer, MICAR teaches the Fourth Estate how to use CAR on microcomputers to uncover stories hidden in the mass of data on government mainframe computers. MICAR conducts seminars and provides technical support to newspapers and other media on how to use the microcomputer to analyze data on mainframes to yield in hours the necessary information that would otherwise take weeks.

According to director Elliot Jaspin, the problem is that most newspapers can't access, and certainly can't afford, their own mainframe computer to analyze the billions of records in a mainframe database.

To solve this dilemma, Jaspin devised a way to "sort out the [mainframe] data and, in other words, divide and conquer." While on fellowship at the Gannett Center for Media Studies, Jaspin and his research assistant Dan Woods wrote a program for Chi controller cards that can read and write nine-track magnetic tapes, which are the principal medium for storing data on government mainframes. The software makes it easy to filter fields and records on the fly from mainframe data sets, so that only the data you need is saved to the microcomputer's hard disk drive for later analysis.

Jaspin first started using CAR while at the *Providence Journal*. In response to a number of deaths of schoolchildren getting run over by buses, Jaspin used a mainframe to match the Social Security numbers of school bus drivers with different categories: those having 10 or 20 traffic violations or criminal convictions, for example. "We were able to do a story on some fairly strange people driving kids around [in school buses]," Jaspin says.

Jaspin cites significant stories written using CAR, including one that found substantial wrongdoing at a Rhode Island housing agency, resulting in the jailing of the agency's director.

MICAR, a nonprofit organization, helps newspapers, radio stations, and other broadcast centers break similar stories in a number of ways: It sponsors week-long seminars; analyzes data for newspapers; provides technical assistance; and is currently researching several software projects to analyze census, hospital, and other data.

Fees for the seminars and research are on a sliding scale based on circulation. MICAR has also begun buying data from the government and selling it to newspapers and

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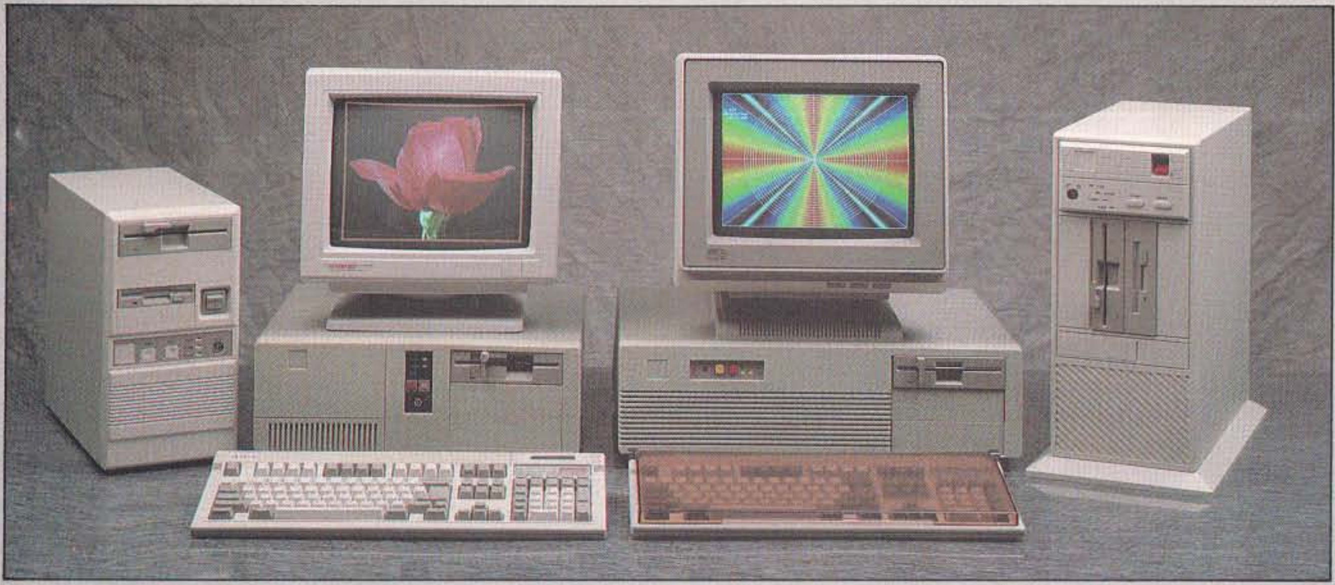

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Jaspin says he and Woods, now his partner, will eventually sell his program in a separate commercial venture. Meanwhile, he'll continue to assist reporters in finding stories through CAR.

Contact: Missouri Institute for Computer-Assisted Reporting, 120 Neff Hall, University of Missouri School of Journalism, Columbia, MO 65211, (314) 884-0684.

Kawasaki: Don't Count Jobs Out

More than 400 Macintosh enthusiasts braved the cold weather to hear Guy Kawasaki, the former Apple and Acius executive, speak at the Performing Arts Center in Milwaukee. In a talk sponsored by North Shore Computers of Milwaukee, Kawasaki promoted his book *The Macintosh Way* and spoke on a number of topics, including his views on Steve Jobs and the NeXT Computer.

"I really would like to see Steve succeed, just because he's great . . . ; however, I'll tell you, I was sort of disappointed with the hardware. I wanted to see a computer that was to the Macintosh what the Macintosh was to the IBM PC. I don't think it's that big a leap, " he said. "Will NeXT succeed? I can give you six reasons why NeXT won't succeed. Like $50 optical media, like the lack of evangelism, like just freezing the system software. But I can give you one big reason that counterbalances and overshadows all the negative reasons: Steve Jobs himself. You should never, ever, ever, ever count Steve Jobs out of the game."

In addressing rumors that he was headed to work for the company, Kawasaki said, "They haven't called me. I'm not about to call them. Rumors of me going to NeXT are completely unfounded. At this time." This prompted laughter from the audience. He said, "I don't know I'd go to NeXT because I don't think I'd want to be merely an evangelist again. I don't think so . . . ; it's kind of like going to a baseball camp when you're 40 years old and can afford it, and you go to the San Francisco Giants baseball camp in Arizona and make a fool of yourself. I don't think that I would do that."

However, he did say later that "money talks."

Kawasaki also had these comments:

- On the Apple Royal versus Adobe ATM font feud: "I think that it's definitely a clash of personalities. Basically, it says that Apple hates Adobe more than it fears Microsoft. And Apple should fear Microsoft more and hate Adobe a lot less."
- In respect to Apple Marketing: "You know what the largest group of migrant workers in California is? Apple marketing people. If you did a Karnak—you know, a Johnny Carson thing—and the answer was, 'Apple marketing,' the question would be 'what is an oxymoron?'"

—Reported by Jean Mickelson.

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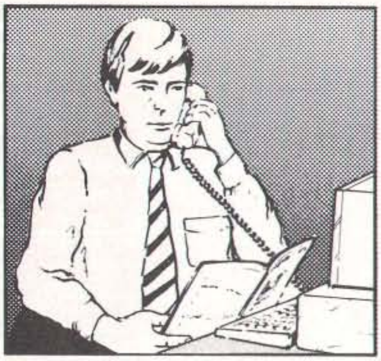

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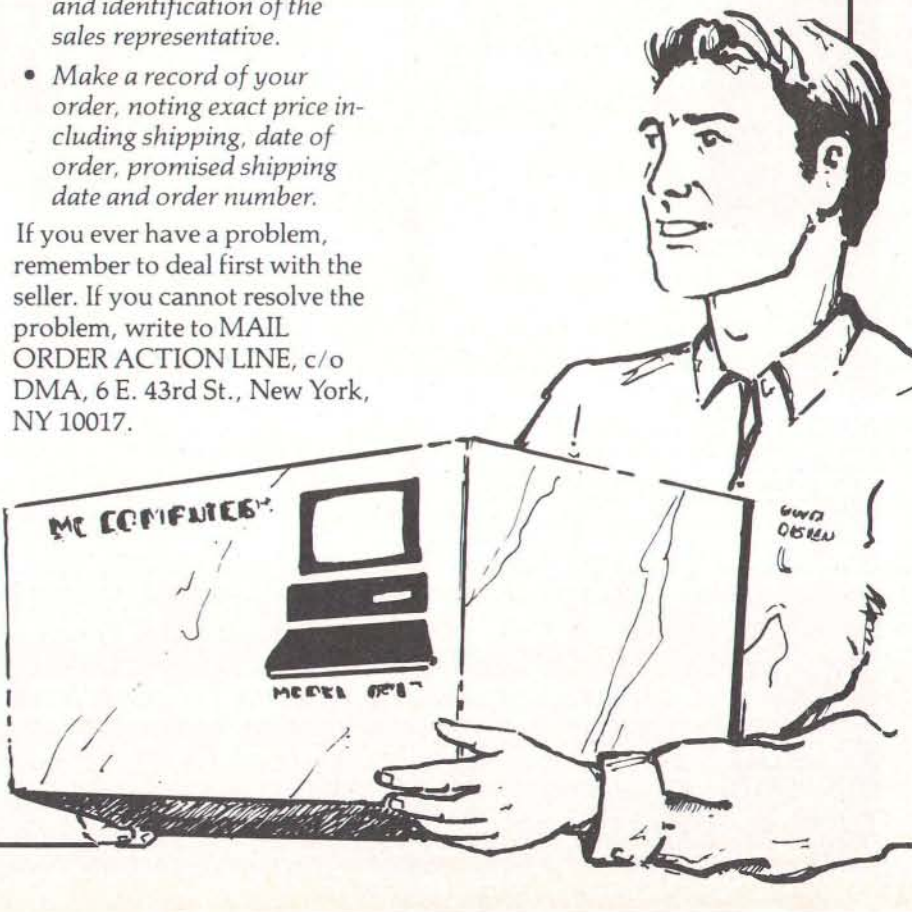

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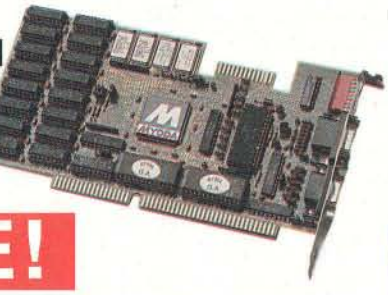

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Both programs capture data in text format from the screens of any program and display the data as graphs. Version 2.0 can create 11 types of single-axis categorical plots, while Analytic can create 16 types of dual-axis *x,y* coordinate plots.

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Contact: New England Software, Greenwich Office Park 3, Greenwich, CT 06831, (203) 625-0062.

Inquiry 999.

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According to the company, PICTure This will convert TARGA 16, CGM, PCX, Sun Raster, IFF (Amiga), GIF, TIFF, RIFF, X.11 bit maps, Macintosh Encapsulated PostScript, and MacPaint formatted files into PICT format.

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Inquiry 1002.

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Contact: Tronix International Data Corp., 10601 South DeAnza Blvd., Suite 216, Cupertino, CA 95014, (408) 973-8559.

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Desktop Publishing for Under $60

With Spinnaker's new version of its Better-Working Word Publisher, you can work in text or graphics mode, letting you edit text in a WYSIWYG environment. The program combines word processing with the ability to create documents using fonts, columns, boxes, lines, and clip art images.

Other enhancements include the ability to scale documents to large, distorted, normal, reduced, and other sizes. You can also pick any column height, and the program automatically reformats the text, the company says. The program includes a spelling checker, outliner, and cut and paste capabilities. To run the program, you'll need an IBM PC with 512K bytes of RAM and a hard disk drive.

Price: $59.95.

Contact: Spinnaker Software, One Kendall Sq., Cambridge, MA 02139, (617) 494-1200.

Inquiry 1004.

Reduce Mortgage Payments with the Banker's Secret

The Banker's Secret Software, a program helpful for people with long-term loans (e.g., a home mortgage), calculates how much money you can save over the years using the prepayment option, the practice of paying more each month than required by your loan agreement. The program can calculate how much money in interest you can save and how many mortgage payments you can eliminate using prepayments.

The program lets you use what-if analysis to see how much money you can save using different prepayments. You can also use it to determine how much additional money you must pay above your normal monthly payment to reduce the term of a loan.

The program runs on the IBM PC with 256K bytes of RAM.

Price: $29.95.

Contact: Good Advice Press, P.O. Box 78, Elizaville, NY 12523, (914) 758-1400.

Inquiry 1001.

Customized Reporting Added to System Architect

A new version of System Architect, the CASE tool for structured design analysis that runs under Microsoft Windows, will support customized reporting and automated documentation, Popkin Software reports. The new documentation preparation facility lets you integrate graphics and reports.

System Architect 2.0 combines diagraming, checks for rule compliance and balancing, and a dictionary/encyclopedia in one package.

Future versions, scheduled for delivery in the first half of the year, include an OS/2 Presentation Manager version, a Structured Query Language server interface, schema generation, and interfaces to code generators.

System Architect 2.0 runs on the IBM AT with Microsoft Windows, 640K bytes of RAM, and a hard disk drive. The program is available in network and merge versions.

Price: $1395; Booch Object-Oriented Diagraming option, $495.

Contact: Popkin Software & Systems, Inc., 111 Prospect St., Suite 505, Stamford, CT 06901, (203) 323-3434.

Inquiry 1000.

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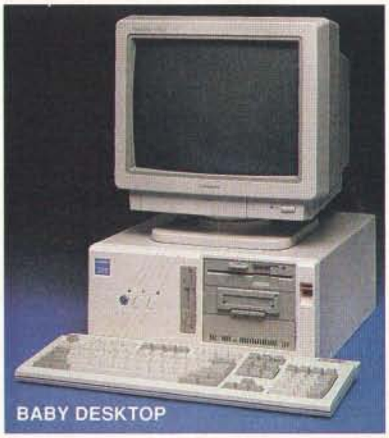

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Page Interleave & Shadow RAM support within BIOS on systems

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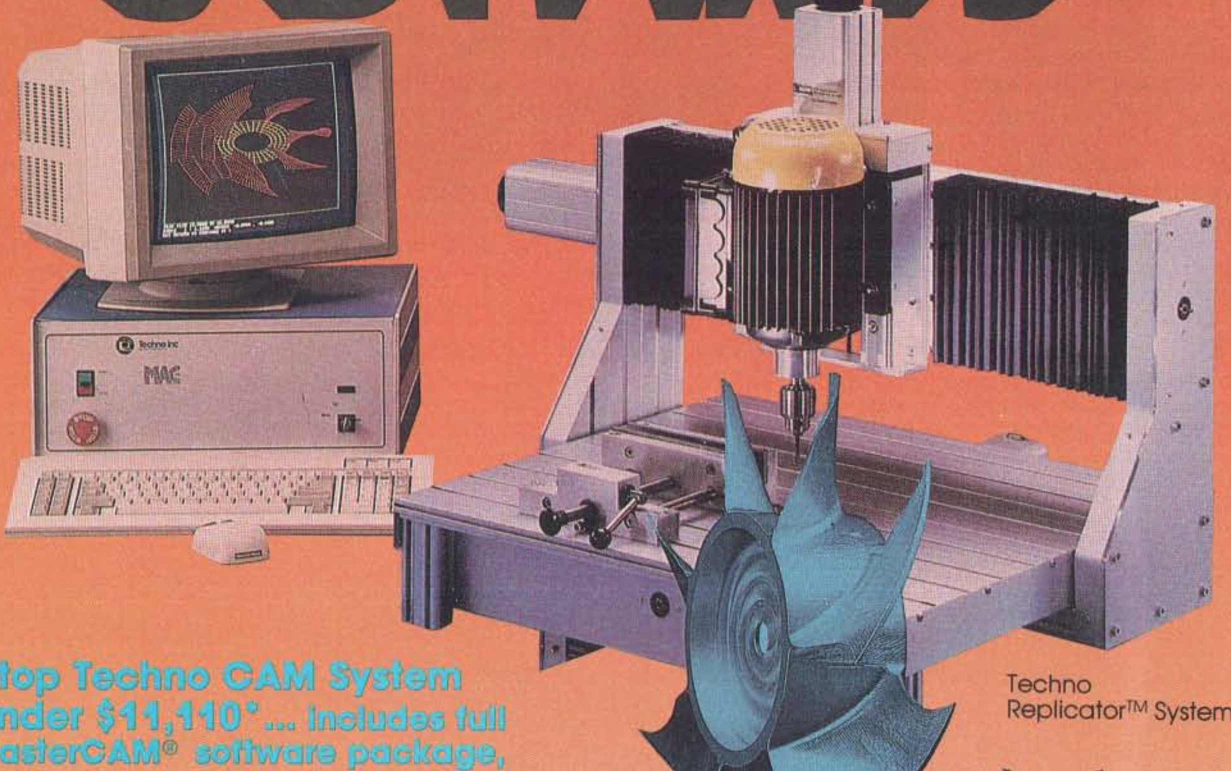

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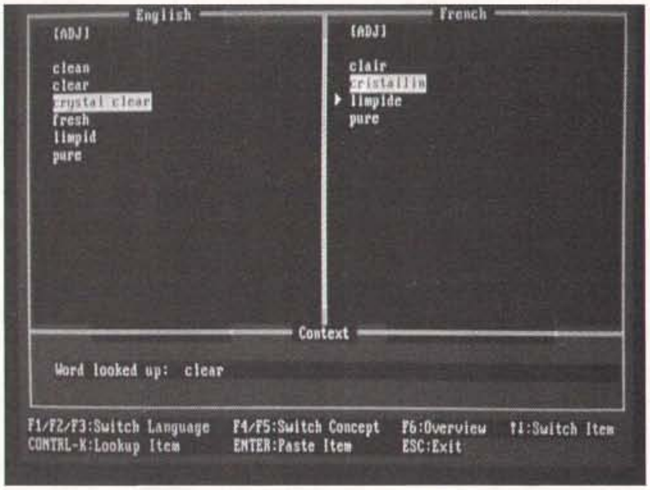
Two Programs for Word and Phrase Translation

Two companies recently released or updated programs that can help you translate words and phrases from one language to another.

MultiTrans, a TSR program for your word processor, can help you translate text in up to five languages. When you request a translation for a particular word, the program presents a literal translation and a set of alternatives. You can then choose the best word or phrase.

The program is available in two versions. A Professional version contains about 50,000 words in the core dictionary for each language, while the Standard version has about 20,000 words. You can switch from one language to another as you edit your document. MultiTrans is available in English, French, German, and Spanish. Microlytics says it will release versions for other languages, including kanji and katakana for the Japanese market, later this year.

The program runs on the IBM PC and consumes about 70K bytes of RAM.
Price: Professional, $395 (includes three languages); $99 for each additional language. Standard, $149 and $49, respectively.
Contact: Microlytics, Inc., Two Tobey Village Office Park, Pittsford, NY 14534, (716) 248-9150.
Inquiry 1005.



```
English                          French
[ADJ]                            [ADJ]

clean                            clair
clear                            cristallin
crystal clear                  ▶ limpide
fresh                            pure
limpid
pure

                      Context
Word looked up:  clear

F1/F2/F3:Switch Language   F4/F5:Switch Concept   F6:Overview   ↑↓:Switch Item
CONTRL-K:Lookup Item       ENTER:Paste Item       ESC:Exit
```

Once you tell MultiTrans to look up a word, the program gives you several options for both languages.

With Translate 2.0, an English-to-Spanish phrase-translation program, you input an ASCII file of English text, and the program returns the Spanish equivalent. The program's algorithms, based on an 80,000-word dictionary, translate complete sentences with the correct gender and number suffixes, Finalsoft says. You can also enter text from within Translate and translate text interactively using a split-screen interface.

The company says that for basic, straightforward English sentences, you won't need to edit the translated text. You can customize the program's dictionary, adding often-encountered terminology.

Translate runs on the IBM PC with 512K bytes of RAM, DOS 3.0 or higher, and a hard disk drive.
Price: $399 until June 30; $495 after.
Contact: Finalsoft Corp., 3900 Northwest 79th Ave., Suite 215, Miami, FL 33166, (800) 232-8228 or (305) 477-2703.
Inquiry 1006.

Sideways Printing Utility for Unix

Flipside, a program for Unix spreadsheet and database users, prints ASCII files sideways on Epson and compatible dot-matrix printers. You can use the program to set margins, font sizes, and character and line spacing from the command line or through an interactive menu interface, according to System Essentials.

The program is available for Xenix and SCO Unix 2.3 or higher systems and consumes 256K bytes of RAM.
Price: $195 to $995.
Contact: System Essentials, Inc., 14858 Grassmere Court, Chesterfield, MO 63017, (314) 537-9537.
Inquiry 1014.

Utility Lets You Boot from Drive B

YWSoft's B:Boot! utility lets you boot your IBM PC from the B drive, which is helpful when the operating system or program that you're trying to install requires you to boot from the A drive and that drive is the wrong size.

For example, if you install a 3½-inch floppy disk drive as drive A and a 5¼-inch floppy disk drive as drive B, you previously couldn't boot using 5¼-inch disks. B:Boot! requires DOS 2.0 or higher.
Price: $19.90.
Contact: YWSoft Co., P.O. Box 2231, Bloomington, IN 47401, (812) 857-4772.
Inquiry 1015.

Hydraulic Calculator for Engineers

With H-Calc, a TSR hydraulic calculator for the fluid conveyance system design field, you can compute or verify hydraulic data within an application.

H-Calc offers the Mannings, Hazen-Williams, and Darcy-Wiesbach equations for modeling piping hydraulics. You can use English or metric units in your calculations. H-Calc determines the flow, diameter, or head loss for a pipe.
Price: $95.
Contact: Engineering Software, P.O. Box 8128, Truckee, CA 95737, (916) 582-1525.
Inquiry 1009.

Color Scanning, Separation Module for Quark XPress

One limitation of Quark XPress, the pagination program for the Macintosh, is that it can generate four-color separations only from elements it creates or from graphics created in Adobe Illustrator and Aldus FreeHand. A company called Pre-Press Technologies says that its Quark extension, SpectreSeps QX, solves this problem by letting you input images from a color scanner and create a four-color separation with a PostScript imagesetter.

The extension requires a Mac SE/30 or II and Quark XPress 2.11 or higher.
Price: $295.
Contact: Pre-Press Technologies, Inc., 2441 Impala Dr., Carlsbad, CA 92008, (619) 931-2695.
Inquiry 1008.

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Navigation Simulation for the IBM PC

With Navmaster, you can simulate the tide, wind, weather, hazards, and other conditions that you'd encounter as you navigate an area of the sea off Nantucket Sound. The program features a navigational chart with buoys, lighthouses, and depth contours.

You can call up a three-dimensional panoramic view of your surroundings, and, in three-dimensional mode, you can also use a hand-bearing compass to practice taking fixes off stationary objects. A binocular function provides closer views of landmarks. In addition to navigational charts, you can also view panels that display your compass, echo sounder, barometer, engine controls, and other cockpit instruments.

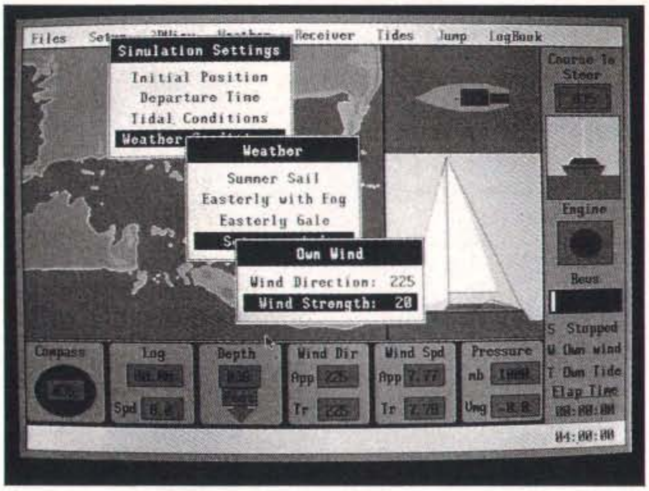
The program includes preprogrammed tide and weather conditions, or you can set your own wind and tide, which lets you experiment with tactics. A Loran C receiver simulates the error patterns caused by hills and mountains that you'd get under real conditions, according to Navmaster's developer.

Navmaster runs on the IBM PC with 512K bytes of RAM. A version for the area off Miami and the Bahamas, including the Gulf Stream, should be available later this spring.

Price: $99.

Contact: Better Boating Association, Inc., P.O. Box 407, Needham, MA 02192, (617) 449-9073.

Inquiry 1010.



Wind Direction: 225
Wind Strength: 20

Navmaster displays your compass reading, wind direction and speed, and other indicators as you simulate the waters off Nantucket.

Keep Track of Floppy Disks with d*Catte

A software system that lets you organize all the records and files on your floppy disks now supports Bernoulli disk drives and is network-compatible, Eagle River reports. Called d*Catte 2.13, the program reads the directory and subdirectories on your disk and enters the disk's critical data in a group of related databases, without writing to or altering the contents of the disk.

The program numbers each disk and lets you include information about each disk, including descriptions of files and programs. If you update the disk, you can edit or add comments as necessary.

Each d*Catte 2.13 database uses the dBASE III Plus DBF format to store information. You can print catalogs of files and floppy disks, and you can use the program to print labels for 3½- or 5¼-inch disks.

The program runs on the IBM PC with 360K bytes of RAM and a hard disk drive.

Price: $139.95.

Contact: Eagle River Software Associates, P.O. Box 22549, Houston, TX 77277, (713) 524-3407.

Inquiry 1013.

Put the World in Your Hands

The newest version of the World Atlas program contains more than 239 country, regional, topographic, and statistical maps, including every country and most dependencies in the world, according to Electromap. In addition to maps, the program covers 59 topics under six areas: geography, people, government, economy, communications, and travel.

The new travel section provides information on visa and immunization requirements, international telephone dialing instructions and codes, electricity, weather, and environmental information.

World Atlas 1.1 runs on the IBM PC with 640K bytes of RAM. The CD-ROM version requires a CD-ROM drive with Microsoft MS-DOS extensions and EGA graphics or better.

Price: $159.

Contact: Electromap, Inc., P.O. Box 1153, Fayetteville, AR 72702, (800) 336-6644 or (501) 442-2309.

Inquiry 1011.

Computer-Aided Gardening

A hypertext-based program called RootDirectory helps you decide what flowers, trees, and shrubs to plant, based on the region in which you live. RootDirectory's hypertext capabilities let you link text to documents and pictures.

The program asks you information like where you live and when you want the plants to bloom. Based on your answers, it provides information about your region. The program contains information on more than 1000 species and varieties of trees and 600 flowers. Information is also included on plant care and propagation, flower heights, and colors.

RootDirectory can help you manage insects and other pests. You can describe the pest by appearance or damage caused, and the program helps you identify pests and recommends organic and natural control procedures.

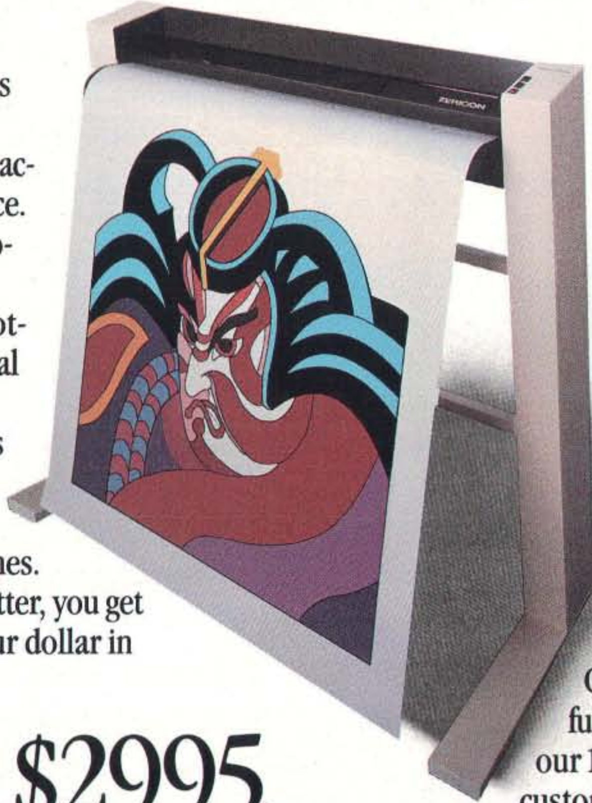
The program runs on the IBM PC with 512K bytes of RAM and a hard disk drive. RootDirectory has three modules: flowers, trees, and insects.

Price: $39.95 per module.

Contact: GardenTech, 1730 Goodman Ave., Redondo Beach, CA 90278, (213) 372-5810.

Inquiry 1012.

Large format plotters for designers who want performance, but can't afford expensive.



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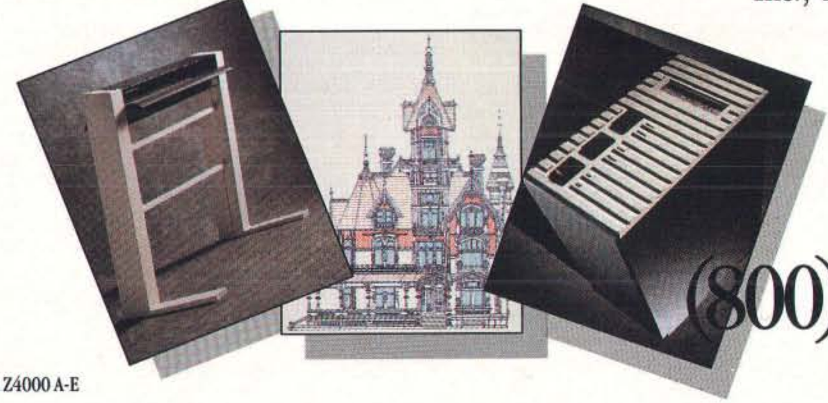

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EXPERT ADVICE

COMPUTING AT CHAOS MANOR ■ Jerry Pournelle

DOUBLE YOUR PLEASURE

Jerry tries to teach an old hard disk drive some new tricks

You're getting this part of the column live. That is, as I'm writing this, out in the Great Hall I'm doing a backup of Roberta Pournelle's Kaypro 386i onto a Maximum Storage APX-4200 WORM (write once, read many times) drive attached to the Zenith Z-386. The files are being transferred over Traveling Software's LapLink III, but they're coming from downstairs, so I had to use the company's DeskLink cable adapters that allow you to send files through a telephone cable.

To make LapLink III do that—transfer files over a telephone cable instead of the big hydra-like cable Traveling Software furnishes with the program—you have to invoke LapLink III with the command "LL3 /3," where /3 stands for "3-wire" (even though there are four wires in a telephone cable). I know I've said all this before, but some may have tuned in late.

Anyway, while that's going on, I'm writing this intro. I'm also kicking myself because while LapLink in Turbo Serial mode is pretty fast, a much faster way to accomplish this would have been to take the WORM drive and its controller downstairs, install the WORM in Roberta's machine, and use XCOPY to transfer all her files; however, I didn't think of that until I'd done much of the job already.

I didn't think of it because her machine is set up in a manner that makes it awkward to get into its case, so we generally back up her stuff with a serial connection—but today the whole point of the exercise is to get a complete backup onto a WORM disk cartridge so that I can install a new disk drive controller into her machine. Clearly that's going to require me to open the case.

Double Your Capacity

It all started at Comdex. For some time, my son Alex, who does data recovery and hard disk drive installation consulting, had told me I ought to connect up with Perstor, a disk drive controller company. Comdex in Las Vegas tends to be the most hectic week of my year, but I noticed that Perstor was having a reception at Bally's, which is where many exciting new start-ups are assigned.

At the reception, I started talking to Perstor Vice President Mark Fife, and I discovered that, in theory at least, they make exactly what we need to upgrade Roberta's favorite machine: a disk drive controller that will let us nearly double the capacity of her hard disk drive.

Since she mostly uses her machine for word processing and communications—she runs the education conference on BIX, as an example—she's more than happy with the speed of the Kaypro 386i, even though it's quite an old machine. I've offered to swap it for a newer computer, but she's not interested. She likes that Kaypro. The problem is that it came with a 40-megabyte hard disk drive, and she's just about filled that up.

"No problem," Mark Fife told me. "The Perstor controller will let you reformat that drive to about double the original capacity. It will be faster, too."

When we got back from Comdex, the Perstor controller, the PS180-16FN, was waiting for us; so now we'll see, which is why I'm backing everything up.

The "Gotcha" Syndrome

It's probably as well that I'm writing this while I wait for the backup, but that isn't what I'd intended to do. I'd intended to play a game called Star Command from Strategic Simulations. When I first got the game, it seemed to have most of the elements I like in a computer game: science fiction, exploration as well as conquest, and a varied scenario. Getting started is a bit tedious, and the user interface leaves much to be desired, but it looked interesting.

What I found, though, is that the purpose of this game isn't for the player to have fun: the purpose of the game is to demonstrate the cleverness of the programmer. No matter what you do in this silly game, there's going to be a "gotcha." If you spend time exploring to discover which planets need what items and then go find places that will sell them, you'll discover there's so little profit it's not worth your time. If you spend time bashing random bad guys—the only real way to raise money—so that you can buy expensive weapons, you'll find that the first thing that's destroyed in combat is that expensive new equipment.

Worse: it *can't* get better. You don't get any new experience points (and thus ability upgrades) until you complete missions, and about four missions into the game is one so tough that the only way to complete it, at the level you will have achieved by then, is sheer luck.

I know, because after the first couple of futile attempts, I took the time and effort to buy about the best equipment possible for my troops; and it's still a series of random events whether I can even get to the place I need to go to begin the mission scenario—and there the preliminary battle will unerringly destroy most of my expensive equipment before I can explore the stuff on the planet's surface. I suppose I could spend hours and hours collecting money to buy spares, but I doubt it would do any good.

I doubt it, because so far, no matter what I've done, the programmer has anticipated me. I can imagine the programmer cackling with glee as yet another obstacle is put into the game. "Think they'll outsmart me and have fun with this, do they? I'll fix them!"

In part, the game is controlled by a random-number generator, so if you play

continued

a scenario often enough, you'll probably get through it; but "often enough" can mean a dozen and more times, each time starting from the beginning because you can't save in intermediate situations. Where is the fun in that?

Meanwhile, the user interface is really stupid: if a character buys a new weapon, he has to go pick a fight with someone before he can equip himself with it, because the "change weapons" menu comes up only in combat. If you want to have characters exchange equipment, it must be done in space; you can't do it at the star base where you bought it. And on, and on, layer after layer of silly menus. They list a dozen play testers in the manual, but I can't believe they actually *played* this game.

The moral of all this is simple: games ought to be designed for the player, not to build the ego of the game designer. Strategic Simulations usually does better than this.

The Perstor Saga Continues

Once I'd backed up Roberta's hard disk, it was time to open the machine and change controllers; and that produced the first problem. Kaypro set up the 386i so that you can't put the cables in wrong. They did this by filling in one hole in each cable connector and cutting off the corresponding pin on the controller board. Since there aren't any cut pins on the Perstor board, it's physically impossible to connect up their board.

That brought on the first of, alas, many calls to Perstor. "Be sure the little '1' etched on the board is in the same place on your old controller and ours, and then snip the corresponding pin," I was told. "No controller uses that line for anything." This took 5 minutes. I didn't bother to remove the hard disk drive.

Next: what kind of drive is this? As with many older machines, we have the user's manual for the 386i, but if there was ever a technical manual, it's long gone. It's a full-height Priam hard disk drive that formats to 40 megabytes and change. Typical of our experience with Priam and Kaypro equipment, it has never given us the slightest trouble despite its age and very hard usage. This was the first 80386 computer to come to Chaos Manor, and the drive has never been out of the machine.

The only real clue was a sticker proclaiming this a Priam ID40, but we couldn't find anything else about it. Unfortunately, the software wants to know the number of heads and cylinders on your drive. Another call to Perstor.

Perstor didn't have any record of the Priam ID40, which is apparently a designation used by Kaypro. Kaypro no longer makes the 386i, and whoever answered the phone didn't think they could find out about the disk drive. Priam is reorganizing, and I wasn't able to make contact there. Mark Fife suggested I try 1024 cylinders and five heads.

The PS180-16FN owner's manual is typical of stuff put out by real technoweenies. In some places it gives you complete information, and in some places it doesn't bother. It's all clear enough, but there are a few glitches, particularly when it comes to telling you how to make a working copy of their software disk.

It's all fine if you have two floppy disk drives, but if you've got only one, it's going to drive you nuts: they have a batch file that copies about 20 files one at a time. This means if you have only one

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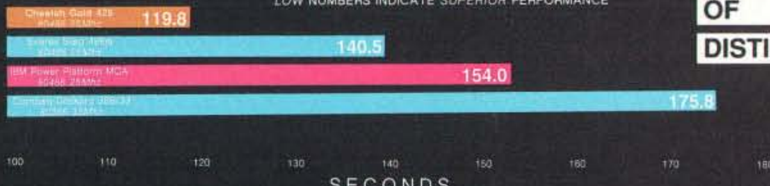

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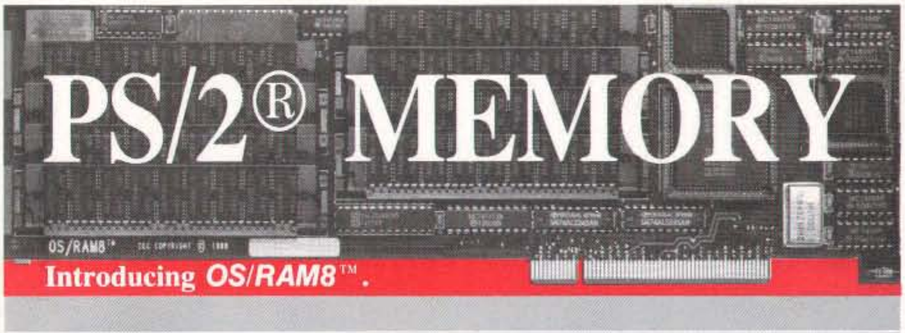
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disk drive, you'll be swapping disks until your arm is tired. My notes for this part of the operation start off with mild complaints and end up with unprintable language.

Barring tennis elbow from disk swapping while making a working floppy disk, there was no problem. First you use your AT Setup program to tell your system there is no hard disk drive, and then you boot up with the painfully constructed floppy disk and follow instructions. In a minute, I came to the question of interleaving.

The Interleave Obfuscation

In what was probably the best book ever written on the game of bridge (*Why You Lose at Bridge*, alas, long out of print), S. J. Simon said "a little knowledge is at least twice as dangerous." That's certainly true for interleave settings.

A disk drive is formatted into tracks and chunks of tracks known as sectors. Sectors are physically laid out end to end around the track; interleave refers to the way your disk drive controller reads information from those sectors. An interleave of 1-to-1 means that the sectors are numbered the way they lie on the track, in consecutive order. An interleave of 2-to-1 means that the disk drive is formatted so that consecutive logical sectors don't correspond to the physical order; the controller reads every other sector. An interleave of 3-to-1 means that the controller reads every third sector.

You'd think, then, that you'd get the fastest data transfer with an interleave of 1-to-1, and indeed some controller manufacturers advertise that their systems have a 1-to-1 interleave, as if that's always the best. The fact is, though, that a 1-to-1 interleave isn't necessarily going to make for the fastest disk drive system, because the disk drive and controller aren't necessarily the slowest components of the system.

That's particularly true with the Perstor controller, which strips data off the hard disk at a full 9 megabits per second, which is faster than most computer buses can accept the data. At a 1-to-1 interleave, then, the controller gets a sector of data, but now, by the time the computer has accepted that data, the disk head has got past the beginning of the next sector. You now have to wait for the disk to rotate all the way around before you can get any more data. Thus, you have an effective interleave not of 1-to-1, but of 9-to-1.

The Perstor software offers to calculate the proper interleave for your computer system. You should let it do that. It takes longer than you think, and while it's doing that, it looks as if your computer has locked up. I stared at an unchanging screen long enough that I thought something was wrong and had dialed Perstor when suddenly things began to happen.

I let the call go through to get someone there to make a note: they really ought to put a message on-screen, or make things flash, or at least note in the manual that this can take several minutes. I'm told they'll do something about that in the future.

In our case, the proper interleave was 3-to-1. That number will be right for many older AT systems, and it's more or less independent of the kind of disk drive.

Problems

The next step is low-level formatting. Unlike high-level formatting, which is what you get with the DOS FORMAT command, low-level formatting completely and irrevocably removes all data from your disk. Some utilities can recover information after a high-level format, but *nothing* will get it back after the low-level job. I'd previously backed up everything onto the WORM drive, so I let the program have at it.

Everything seemed to go well. The job took about 10 minutes. Once the disk drive is formatted, the software asks if you want a media examination. You should definitely do that. The test will destroy any data on the disk, but after a low-level format there won't be any.

You're then asked whether you want to add any disk drive defects as listed by the manufacturer. The manual makes a point of saying it's important that you do it, but in fact you shouldn't. Often, the Perstor controller will be able to make use of sectors that your original controller had trouble with, and besides, the Perstor tests will have found any unusable sectors. If you're at all concerned, the thing to do is finish the installation, and when your system is up and running, use something like Golden Bow's Vmarkbad (which comes with their Vopt program, definitely recommended) to examine the disk drive just in case.

Once the format job is done you can reboot, still with the floppy disk of course.

FDISK Is Stupid

It was then time to partition the newly formatted disk drive. Alex is fond of the SpeedStor utilities for doing this, but I try to keep Roberta's system as vanilla as possible, so I booted with my IBM DOS 3.3 master disk and ran FDISK.

FDISK couldn't find the hard disk drive.

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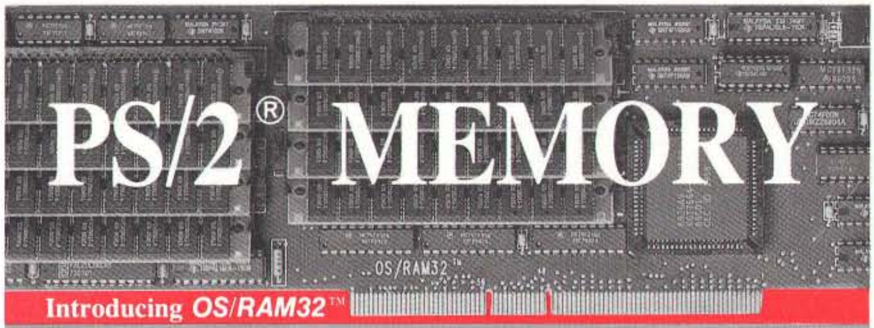

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Now, FDISK isn't a very smart program. As I've reported before, it will not only allow, but encourage, you to do things you'll regret. Even so, it ought to *find* the drive. Time for another call to Perstor.

Mark Fife referred me to a technical-support person. After I described what I'd done, he wondered about one of the steps. "When you used the Setup program to tell the system you don't have a hard disk drive, what hard disk drive type did it think you already had?"

The Perstor installation instructions hadn't told me to record that, but fortunately I'd done it anyway, because if this Perstor upgrade didn't work, I'd have to put Roberta's machine back the way it was, and I would need that information. "Type 17," I said.

"There's your problem," he said. "That's five heads and 977 cylinders, not 1024. You'll have to reformat with the right information." He also assured me I'd done no harm: you can format a disk drive any way you like. It won't work properly if you lie to the controller, but you won't hurt the drive itself.

"How do you know what type 17 is?" I asked. It turns out Perstor has a table that relates drive "type" as demanded by the Setup program and the actual drive specifications of heads and cylinders.

Anyway, I gave the Perstor program the new parameters and set it to work, and then I had to go to an appointment. By the time I got back, it was after office hours in Perstor's time zone; and although I'd reformatted to the new (and correct) specifications and did everything else right, FDISK *still* couldn't find my hard disk drive.

Reinforcements

At this point, it was clearly time to call in the heavy artillery. I mean, what's the point of sending your kids to college if you can't pick their brains? So I called Alex, who got his degree in computer science and makes a good living recovering data from crashed hard disk drives. I explained the problem. "Worse," I said, "it's your mother's system, and she wants it working. *Now*."

Alex came over, but he couldn't make it work either. The best we could do was put the system back the way it was with the original Western Digital controller. Alex noticed that Roberta has a lot of little bitty files in her system, and he used SpeedStor to change the sector size from 4K bytes to 2K bytes. This means that the minimum file size is now 2K bytes, thus saving some disk space at the minor expense of having the SpeedStor driver software take up a bit of memory; but clearly we hadn't doubled Roberta's disk capacity despite our promises.

Alex couldn't figure it out. "I know Perstor works. We install it for clients. We've put Perstor controllers in a couple of dozen systems, and I've never had any problems."

All of which left me in a dilemma, because this column is based on what happens here, and what had happened here was that it didn't work.

Comes the Dawn

Next day Roberta needed her machine, so I left it alone; the morning after that she had an appointment. "Did you make any new files yesterday?" I asked, but that was silly. Of course she had. I strung the DeskLink cable between her machine and the Z-386 with its WORM drive and used LapLink III; this time, I noticed there was a "date" feature in the LL3 options.

You can tell it to copy all and only those files from a given date, before that date, or after that date. I set that to our last backup date and let fly; sure enough, LapLink searched through all the directories and subdirectories and found the half-dozen or so files she'd accessed and rewritten since the last backup. That's one great program.

That done, I took the machine apart, reinstalled the Perstor controller, and dialed—well, punched—the by-now-familiar Perstor number. This time they weren't fooling around: they put me through to Safa Matin, who's one of their best technical people. We went through a number of tests, including making certain that I'd chopped off the proper pins and had the cables connected up right. I removed the disk drive from the cage and checked to see that it had a terminating resistor. We did a bunch of other stuff.

"Cables. Have you got a spare data cable?"

I nearly kicked myself. For years I have been telling readers that if things go wrong, one of the first things to suspect is cables. Worse, I've known for years that the flat disk drive connector cables are subject to failure at the connector ends when you unplug them and plug them back in. I should have checked the cable first thing.

This time, though, it wasn't the cable. We still had a problem.

Under Safa Matin's direction, I loaded in DEBUG and did some tests. The results weren't good.

"The drive has changed state," he said. "Let's try this. Leave the system powered up but pull the power cable off

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the disk drive." I did that and then went into DEBUG and used that to change several bytes in memory. I wouldn't have had the foggiest notion of what to do without directions.

"Now try FDISK."

No problem. FDISK could find the drive; but when I rebooted, it lost it again. Going in with DEBUG showed that we were back where we'd been.

"What is the model of that drive?"

When I'd pulled the drive out of the case, I found a new label plate. "It says V-150."

"It's the 'seek complete' problem," Safa said. "That is one of the oldest models of Priam disk drives. It doesn't properly handle the seek complete signal. We called Priam's attention to the problem years ago, and they fixed it on all their subsequent models." All of which was fine, but it wasn't going to help me now. I thanked him and hung up to think about the situation.

I could just put it back the way it was, but I hated to do that. Finally, I called Alex. "I need a hard disk drive. Got one in stock?"

An hour later he brought over a reconditioned CDC Wren-5 Model 94205-51, presumably one he'd refurbished after recovering data from it for a client. The 51 indicates that its nominal capacity is 51 megabytes unformatted, meaning that it normally formats to about 40 megabytes. It also comes with papers listing the number of heads and cylinders and other vital information.

For years, CDC and Priam have had the reputation of being the best-quality drives on the market. Unfortunately, as I write this, Priam is in financial difficulty, and CDC has been bought out by Seagate, a company that, to put it delicately, doesn't have quite the same reputation for quality control that CDC has. Alex says that so far CDC remains an autonomous part of Seagate, with the same high standards as always.

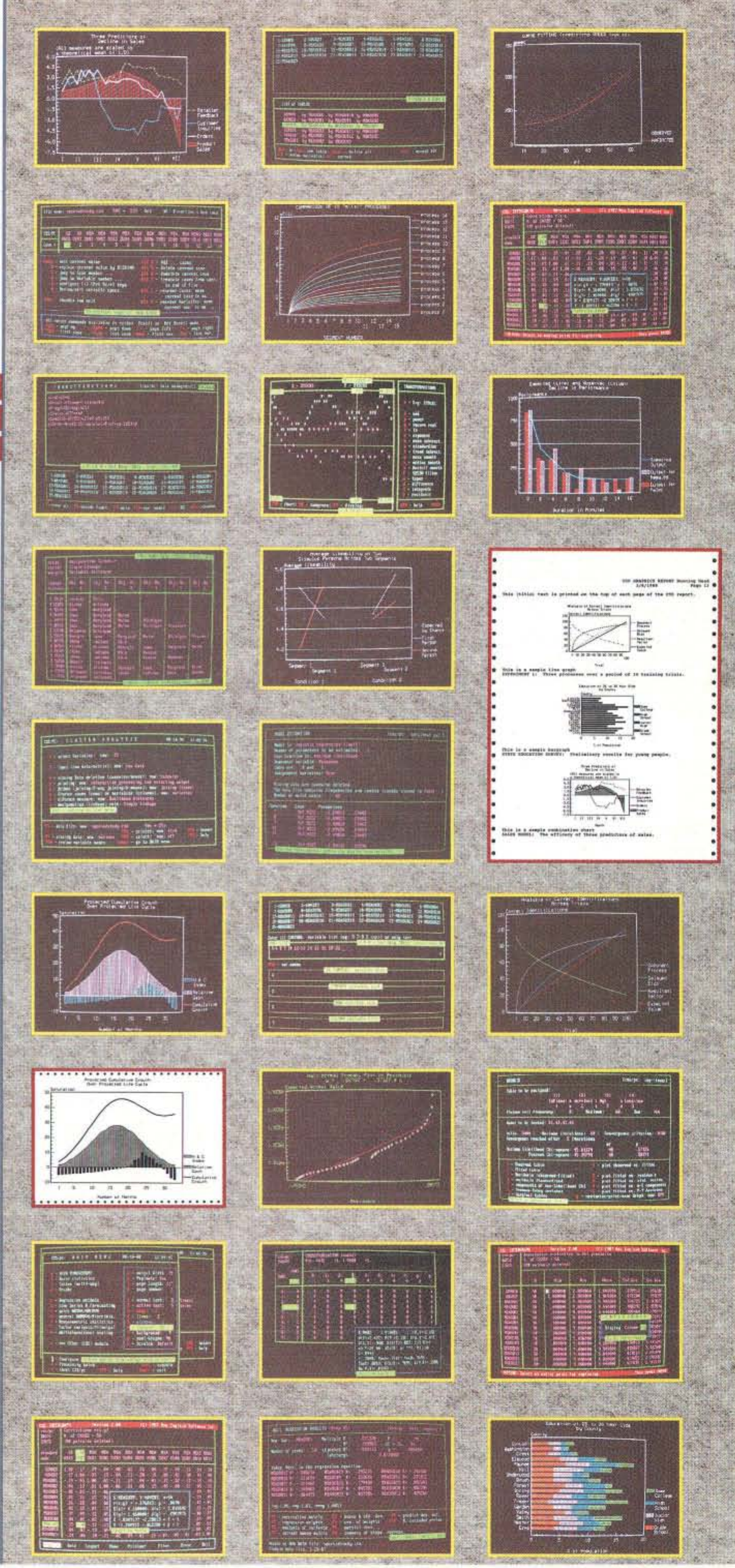
Happy Ending

It took about 5 minutes to install the new CDC drive. Unlike the Priam drive it replaced, this drive is half-height, and it has a "selected" light on the drive itself. There was no problem fitting it into the Kaypro case.

There was no problem with the Perstor software, either. I merely followed instructions, letting the software compute the interleave factor (3-to-1), format the disk drive, and examine it for defects. When it asked for disk drive defect information, I didn't enter any, even though the drive had come with a list of about a dozen bad sectors.

FDISK had no trouble finding the disk drive, nor in partitioning it. We got drives C and D at 33 megabytes each and drive E at 11 megabytes, for a total of 77 megabytes formatted on a drive that's supposed to have only 51 megabytes unformatted (or 41 megabytes formatted). I then transferred all Roberta's software from the WORM drive—Alex says it ran faster because the data was flowing downhill—and ran Vmarkbad. No bad sectors. I

continued



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tried Norton Disk Doctor. Same thing.

We ran Coretest, the disk drive speed test utility. Coretest reported the speed index for Roberta's system is 3.9; with the old controller it was 1.3, and although we changed the drive, that's about the improvement we would have got if we hadn't changed it, since the seek times and suchlike are about the same for the CDC and Priam drives. The speed difference is quite noticeable; even booting up is much faster.

So. Perstor's controller works fine. It will nearly double the capacity of your hard disk drive; it will make your disk drive system faster; and it may recover some "defective" sectors while it's doing all this. While we've only just installed it on Roberta's system, Alex has put Perstor upgrades into a number of client systems and has no hesitation in recommending them. Provided that you have a standard drive in good condition and no defective cables, installation is a snap.

The Perstor controller will work fine with most disk drives, including most older Priam drives; if you have any doubts, check with Perstor.

I especially commend Perstor's telephone-support troops. Certainly they knew who they were talking to; but I find from talking to other Perstor customers that I didn't get special treatment. These people know their product and know how to tell you what to do to locate the difficulty. Depending on just how much hand-holding you need, they reserve the right to charge you for telephone consultation; that doesn't happen often, and if it does, the advice you get ought to be worth the money.

Perstor has both 16-bit (AT) and 8-bit (XT) controller cards and software. If you have a computer that's good enough except that the hard disk drive is slow and doesn't have enough capacity, consider replacing your controller with a Perstor. Roberta is sure happy with hers. Highly recommended.

Comdex '89

It was by far the biggest Comdex yet. One notable event was the BYTE Breakfast, where we presented the Shelly Awards. Named for Comdex founder Sheldon Adelson, these are the BYTE editors' choices for hits of the show.

The best party at Comdex was given by Seikosha Industries on Sunday night. It was quiet and elegant, excellent food, no loud entertainment—I have never understood why one would want to fill a room with interesting people and then

continued

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make it impossible for them to talk to each other. Seikosha has several innovations in printer technology, and I suspect you'll be hearing more about them.

The most courteous act at Comdex came when the Cheetah people tried to set up their new i486 machine as one of the exhibits in the Pick operating-system room and discovered they didn't have a working VGA monitor. Zenith Data Systems generously lent them a Flat Technology Monitor (FTM), not just for the day but for the length of the show. The Cheetah 486 ran the Pick operating system at impressive speeds, and with that wonderful Zenith monitor, it was one of the more colorful demonstrations. I got to meet Dick Pick, and I'll go to Orange County to see him sometime next month. More on Pick in another column.

The most spectacular thing I saw at Comdex was a hospitality-suite demonstration of VideoLogic's new video boards. I am supposed to be getting one soon, so more then: but imagine being able to have your favorite TV channel going in a small window in your Zenith FTM while you bang away at your word processor. And other such marvels.

The most impressive small company—actually one of the most impressive companies of any size—was Sota, with new state-of-the-art (which is what their name stands for) high-resolution, monochrome VGA systems, upgrades for older AT systems, and generally a broad line of high-tech capabilities. It's worth keeping up with Sota to see what they're doing.

I suppose the oddest event at Comdex was to be asked to go to the Ashton-Tate booth, where I was presented with a bottle of Russian cognac. It appears that the programmers' association over there had voted me the most popular computer columnist in the USSR and sent the cognac through the Ashton-Tate Moscow rep as a token. I haven't quite recovered from the shock, but then there are a lot of things happening over there. I certainly appreciate the honor.

Look That Up . . .

Comdex this year spread all through Las Vegas. When leaving town, we stopped at the Tropicana, the last hotel on the strip, where we saw the Inductel people.

Inductel, you may recall, publishes the Funk & Wagnall's Standard Desk Dictionary, as well as a 26-language translator and a bunch of McGraw-Hill technical dictionaries. The dictionaries reside on your hard disk, and all of them can be accessed through the same software; that software can be memory-resident or invoked as a stand-alone program. In my previous report, I was enthusiastic about the program but disgusted with their installation procedures.

Apparently someone at Inductel actually listens. They're revamping the manual, changing the installation, and getting to work on the user interface. By the time you read this, the Inductel Reference Series will be considerably improved, mostly along lines suggested in a previous column.

My previous rating was "infuriatingly excellent." We'll see what comes out of the improvements. Meanwhile, they've sent replacements for the bad distribution disks I had before, and this time I got the program running without a hitch in Big Cheetah. It really is fast, and although I still think the user interface is counterintuitive, you *can* get used to it. If you want an on-line dictionary system, this is very complete, and I'm rapidly becoming addicted to it.

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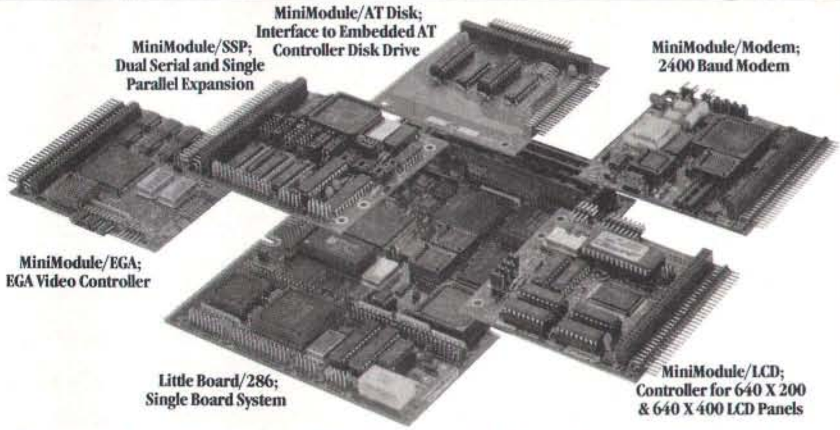
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AutoPilot

One of my pet peeves is inadequate Install programs, as, for instance, last month's example of the WORM software that wouldn't install from the B drive. Incidentally, we do make progress: Maximum Storage just sent me an update to its software, and this one will install from any drive you can get it on.

One way to make reasonable Install programs would be to use something like AutoPilot. This program advertises that it "picks up where DOS left off"; and that's not a bad description. AutoPilot is a job-control-language compiler. It will enhance your old DOS batch files, and much more. The language is rich and powerful. It will create menu-driven scripts. There's even an editor. It would be ideal for making Install programs.

Alas, you can't use AutoPilot that way, because it doesn't have any provision for making stand-alone programs. The result is that AutoPilot falls between the cracks. It's not a full-fledged language you can use to produce utilities for others to use; at the same time, it requires considerable knowledge of DOS to make intelligent use of AutoPilot. The manual says that experts can create scripts and programs for naive users, and that's correct—but so what? Their license agreement specifically says that each user has to have his or her own copy.

I can see AutoPilot used by a consultant in setting up a user system. The cost of the user's copy would be part of the fee. Indeed, I can recommend that people in the business of setting up computer systems for others look into AutoPilot; it could save a lot of time in such applications. In that context, recommended. I wish it had a stand-alone mode, though.

Objects

I'm only now beginning to appreciate the power of object-oriented programming (OOP). This may be one of the really significant breakthroughs of the small computer era. Specifically, I'm looking at Turbo Pascal 5.5; and every time I look, I am amazed at what you can do and how *quickly* you can get it done.

Longtime readers know that I consider Modula-2 the language of choice for most professional programming jobs. I say this despite the popularity of C and the known problems of Modula-2 in the library standard and I/O departments. One reason for my preference is that Modula-2 modules are much like the "objects" in OOP. I know there are significant differences, and I expect some mail about this statement; but my point is that Turbo Pascal 5.5 with its OOP features is now a serious competitor of Modula-2, especially for The Rest Of Us.

For those interested in knowing more, there are two excellent books. Ben Ezzell's *Object-Oriented Programming in Turbo Pascal 5.5* (1989, Addison-Wesley, $22.95) assumes you already program in Turbo Pascal and gets right down to what you can do with OOP and how to do it. The book will make little sense to those unfamiliar with Turbo Pascal, but for those doing Turbo Pascal programs who want to know about objects, this is the book to get.

Tom Swan's *Mastering Turbo Pascal 5.5* (1989, Hayden, $25.95) is the third edition of a well-known standard introduction to Turbo Pascal. It assumes that you know something about computers and DOS, but not much more, and takes you from beginner's level to advanced intermediate. No single book will make you a programmer, but this one comes as close as any could. I do recommend that after you've gone through Swan's book, you get Ezzell's. They're both excellent.

Build Your Own Mac

Outfits like Broderbund keep making excellent print-shop tools for the IBM PC, but everyone I know who has access to both systems prefers the Macintosh for serious desktop publishing. This includes Alex, who produced the program book for the recent LOSCON science fiction convention on my Mac IIx but does most of his actual work on an 80386 PC.

The problem with the Mac is the cost. Good machines, but they do tend to be pricey. There are two solutions to the cost problem. One is to get an Atari ST and the Gadgets by Small cartridge that turns the ST into a Mac. Dave and Sandy Small were demonstrating it in the Atari booth, particularly with the Atari Stacy portable ST, and you couldn't get into the demonstration because it was so thickly crowded with Apple engineering people. Atari can't make the Stacy fast enough. More on that another time.

The other solution is to make your own Mac. That sounds harder than it is. The way to find out whether you want to try it is to get *Build Your Own Macintosh from Catalog Parts—The Cat Mac* by Bob Brant (Brant Associates, 4420 Southeast Mark Kelly Court, Portland, OR 97222). In the Mac tradition, this rather thin book carries a high price of $24.95, but it's almost certainly worth it if you're serious about building your own Mac.

Indeed, it's worth having the book even if you have a standard Mac out of warranty (as most Macs are, Apple being less than generous in their warranty terms). This book goes into what's available, from motherboards and hard disk drives to cables and connectors; who sells the stuff and for how much; and how difficult it is to replace or install. It covers everything from assembling a Mac from catalog parts, no soldering required, to fixing up a "Hackintosh." The book recommends that you build your own Mac SE and goes through the author's experiences in doing that.

I've had a few MacExpert friends look through this, and they think it's nifty.

Winding Down

As usual, there are piles of stuff here I haven't a hope of getting to. There's PowerBasic, a new non-Borland edition of Turbo Basic from the original author; looks interesting, but I haven't tried it. There's Dan Bricklin's PageGarden, a hard-to-use professional laser-printing program that is nearly indispensable if you're using the IBM PC for printing forms, notices, and anything repetitive. There are some new marvels from Sota, and at least three ways to refurbish your old AT into a machine that will last a few more years; I'll get to those next month.

Several books this month: *Z88 Magic* by Vic Gerhardi et al. (Kuma Computers Ltd., Pangbourne, Berkshire, UK), an excellent tour through the Cambridge Z88 computer. I still carry Sir Zed and remain fond of it. Second, *The Cuckoo's Egg* by Clifford Stoll, a fascinating account of how an astronomer tracked down a computer cracker (1989, Doubleday, $19.95). [Editor's note: *In this month's Print Queue, Hugh Kenner reviews* The Cuckoo's Egg.] Finally, Terry Pratchett has a new "Discworld" book, *Wyrd Sisters* (Gollancz, London). If you don't know Pratchett and Discworld, you've a treat in store. He's the funniest fantasy writer I've come across.

Next month, the Annual Chaos Manor Awards for most useful computer products, and the Chaos Manor annual Orchid and Onion parade for the best and most annoying things to happen. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

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**Written by Neil Martin of the British Standards Institution (BSI) and printed in Personal Computer World June 1989, page 241.*

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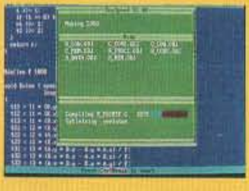

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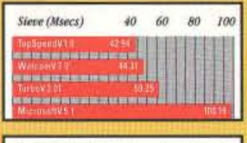

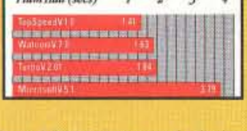

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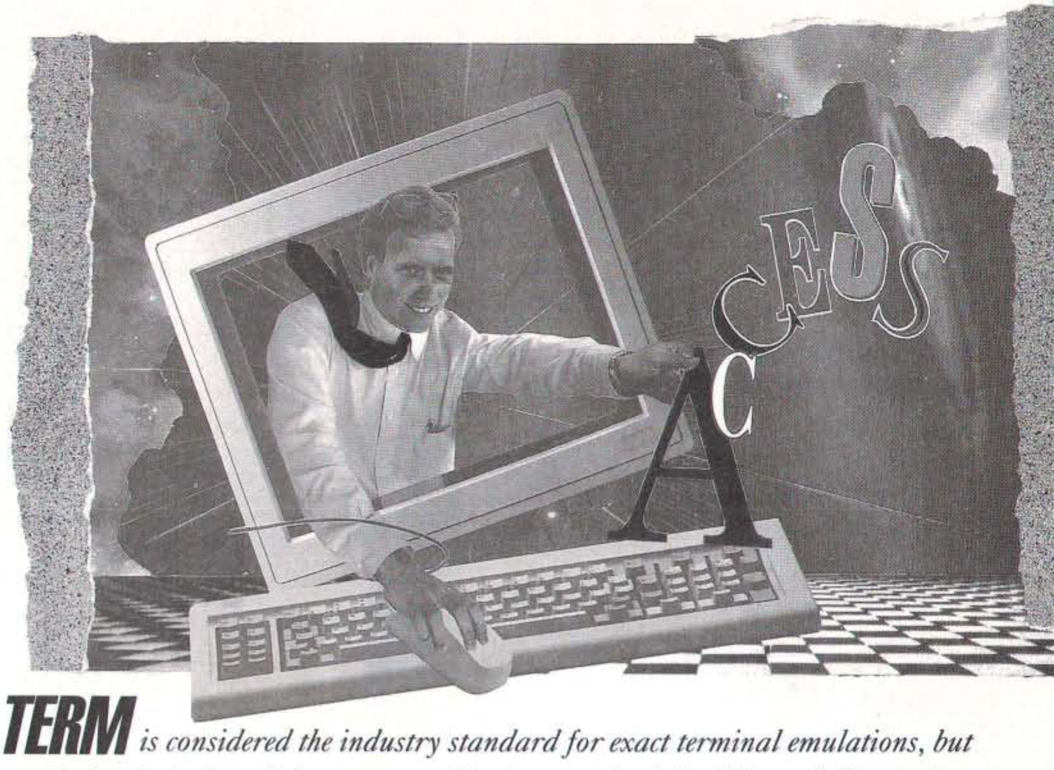

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TERM is considered the industry standard for exact terminal emulations, but emulation isn't the only issue – regardless how precise it is. The real objective is access, and accessibility requires that your machine act like their machine.

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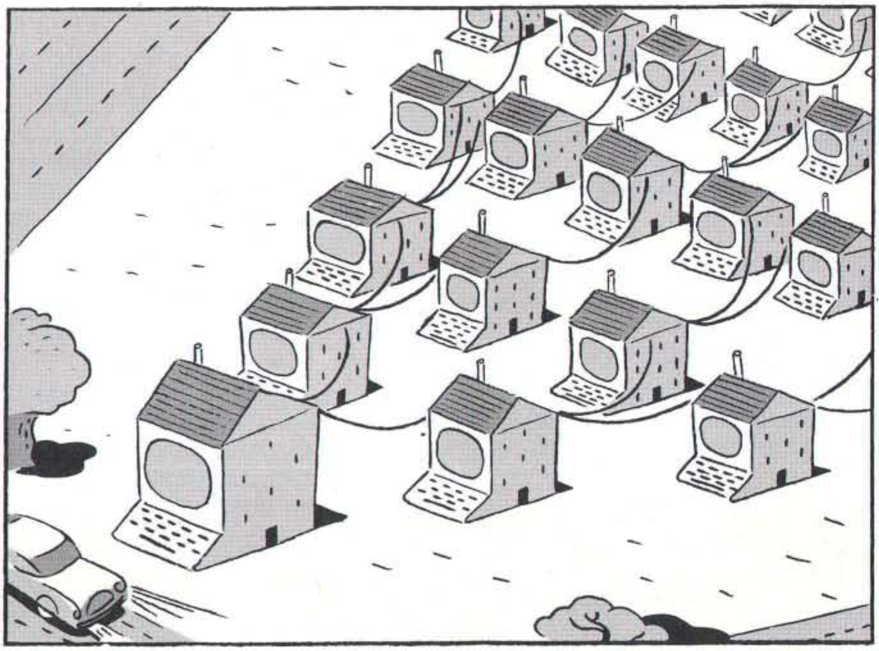
LET YOUR FINGERS DO THE TALKING

Unix has programs that let you communicate with the outside world



A Unix environment can be productive and seductive at the same time: productive because of all those wonderful tools, and seductive because there are so many tools and options on Unix that you can spend an afternoon just learning new ways of doing things, without actually getting anything done.

Other than reading the manual and trying everything in it, or browsing the file tree and examining interesting files, there is probably no easier way of getting distracted than using the Unix mail and news facilities. For some people—I confess to being one of them—the ability to communicate with people all over the world from your terminal can be distracting beyond comprehension. While almost everyone likes to communicate, somehow adding technology to the experience makes it more interesting or (dare I say it?) fun. This explains the popularity of E-mail, amateur radio, fax machines, cellular phones, and even paper cups networked by a piece of string.

In the case of Unix, I have numerous ways to distract myself. The basic one is `cu`, which is a simple telecommunications utility that will dial out via modem and let you connect to other computers. Once connected, your terminal becomes a remote terminal on the other computer, which doesn't have to be running Unix. You can also use `cu` to test a dial-up to another Unix machine, or to send characters to a modem for setup and diagnostic purposes. Commands internal to `cu` allow you to exchange files with other Unix machines, though without any protocol or error checking. You can also run commands (either locally or remotely) and send their output to your screen or to the modem.

UUCP

The next step up from `cu` is the set of commands that AT&T calls basic networking utilities. BNU includes programs to copy files (`uucp`, `uuto`) and execute commands across system boundaries (`uux`), as well as to perform a number of status and diagnostic functions (`uutry`, `uustat`, `uulog`). Everyone in the Unix world, however, refers to this entire command suite collectively as UUCP (for Unix-to-Unix copy).

Once properly installed, UUCP runs more or less automatically, executing your remote commands and transfer requests without your having to do anything but specify the name of the system you want to call. And while you generally find software of this sophistication only with LANs, UUCP just needs regular dial-up modems to operate. Log-in scripts for all systems are standardized and contained in a single file. Calls to a particular system can be made as soon as a request is issued for that system, or deferred until another time, perhaps when the phone rates are lower.

UUCP has reached several important milestones since its inception. Several years ago, it was completely rewritten to provide more security, more generality, and, best of all, easier setup and installation. Peter Honeyman, D. A. Nowitz, and Brian E. Redman created this version, and it is therefore generally known by the acronymish HoneyDanBer UUCP to distinguish it from the older version. HoneyDanBer (sometimes referred to as HDB) UUCP is the standard on all current AT&T-derived releases of Unix.

More recently, the number of UUCP users reached a critical size that led Telebit (1345 Shorebird Way, Mountain

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View, CA 94043, (415) 969-3800) to design a series of modems with built-in support for the UUCP protocol. Its TrailBlazer Plus has its own 68000 CPU and digital signal processor and connects to your machine via a serial port at 19,200 bps. It needs that kind of speed to keep up, because it can converse with compatible modems at up to 18,000 bps while emulating UUCP in its own hardware. This approach takes a big load off your computer's CPU, allowing real-world throughput of between 900 and 1600 characters per second (at least, that's what I get). This corresponds to about a megabyte of data every 15 minutes or so and partly explains why the Telebit modems have become a de facto standard in the Unix community. Parenthetically, the TrailBlazer Plus also supports normal modem protocols at 300, 1200, and 2400 bps, and a new Telebit 2500 model supports the V.32 standard at 9600 bps as well.

E-Mail

Many first-time Unix users are astounded to find out that the regular `mail` command can be used to contact users on other systems. The `mail` command automatically invokes the UUCP subsystem to transfer mail messages to another Unix machine. The catch here is that a UUCP connection must already be set up with the other machine, or else you must know an explicit "path" to the other machine.

While I'll get into the specifics of setting up UUCP in a future column, all Unix users should know some of the ins and outs of mail addressing. The first thing to know is the "nodename" of your own machine—that is, the name by which other machines can address your machine. To find out, execute the command `uname -n`. The result should be a name of eight characters or less.

On my own computer, the nodename is `infopro` and my log-in is `david`, so my full E-mail address via UUCP would be `infopro!david`. While another user on my own machine would merely have to type `mail david` to reach me, a user on a machine with a direct UUCP connection to my machine would have to type `mail infopro!david`.

This is fine for a small number of connections, perhaps among company sites. But with thousands of Unix machines talking to each other, it's not possible to set up a connection to every machine directly. So an informal UUCP-Net has been set up with the mutual cooperation of system administrators around the world. Computers on UUCP-Net agree to pass mail messages to and through each other, so that you only have to know the correct path between machines to route your message. For this reason, many people on UUCP-Net provide, as part of their electronic signature, a number of well-known machines that their machines "talk to." This allows people they correspond with to answer them reliably.

As an example, I might use the line

```
{bytepb,hoptoad,pyramid}
    !infopro!david
```

as part of my signature (actually, a `.signature` file in my home directory that is automatically appended to all my outgoing mail). This signifies, in C-shell notation, that the three machines `bytepb`, `hoptoad`, and `pyramid` all talk to my machine, `infopro`, on a regular basis, and that mail sent through them should get to me. So, if your machine is called `hello`, your log-in name is george, and `hello` talks to `pyramid`, then typing `mail pyramid!infopro!david` would get a message to me. Similarly, I could talk to you by typing `mail pyramid!hello!george`.

You can see where this is leading. If your machine *doesn't* talk directly to `pyramid`, you'll have to find an intermediate machine that does. Four or five years ago, one of the most valuable items an E-mail freak could have was a copy of Mark Horton's net map, which let you figure out the paths to any other machine by actually following lines between machine names. Now, there are so many machines on the network that all routes are generated electronically, using special software and volunteers around the world who coordinate map entries.

My routing file contained 17,687 entries on the day this article was submitted, each one optimized for the fastest path from `infopro` to every other Unix computer on the planet known to be on UUCP-Net. Every morning, a set of shell programs that I wrote checks the latest map entries and regenerates the routing file if necessary. The mail software I use automatically reverses the path of any incoming mail messages for sending replies and uses the routing file to find a way to other computers where only the final nodename is known.

Usenet

So where do these maps, entries, and software packages come from? There's another set of programs, apart from BNU and mail, that takes advantage of your UUCP capabilities. It allows any user at a participating site to read and

continued

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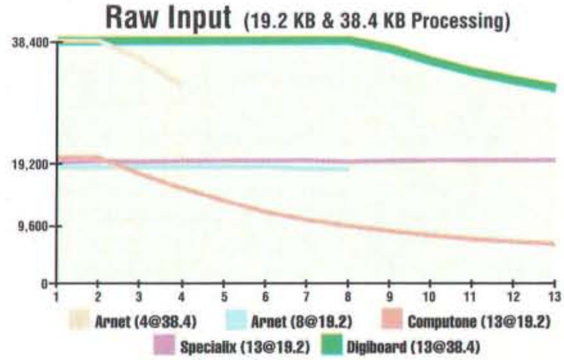
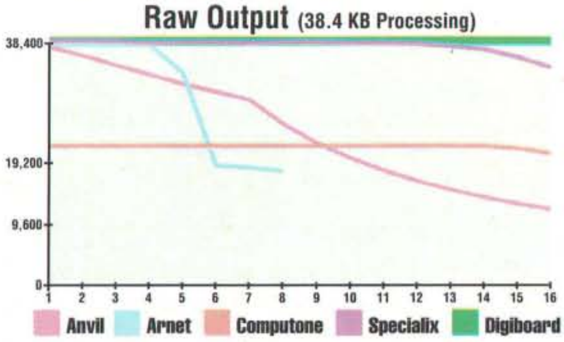
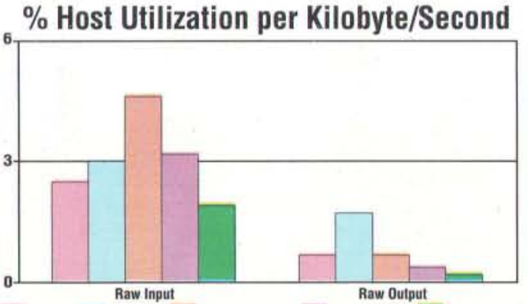


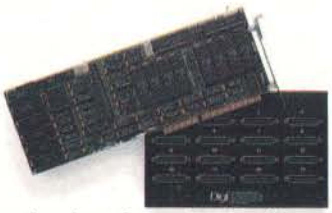
Raw Input: Primarily data received via host-to-host communications. The higher the better.



Raw Output: Processed data from host applications to terminal users (spreadsheet, word processing, etc.) The higher the better.



Processor Overhead: Percentage of host CPU time utilized for I/O processing tasks. The lower the better.



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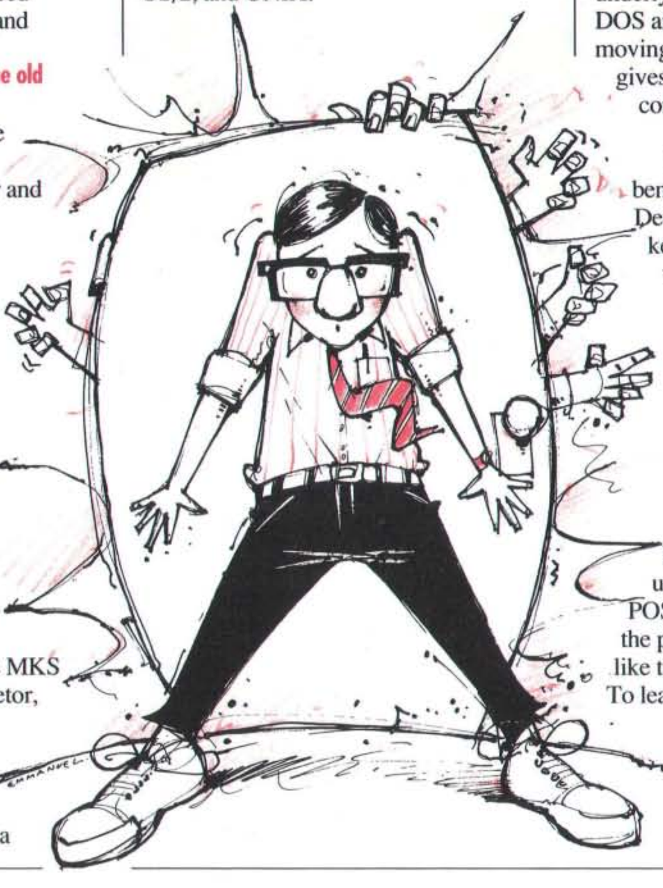

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write (or post) electronic articles in any one of hundreds of newsgroups. It is called Usenet News, Netnews, or simply "the news." The machines that run this software and that have agreed to pass the news articles on to others make up the Usenet.

Newsgroups range from the deeply technical to the merely bizarre, and each one is a sort of interactive mini-magazine that is written largely by the same people who read it. While it's hard to characterize Usenet in a few words, I believe I can honestly say there is something there for everyone. Think of it as an electronic version of Hyde Park.

If you aren't interested in communicating with other Usenuts, there are more-pressing reasons to sign up (and by the way, Usenet is free). In the newsgroup `comp.mail.maps`, you will find the map entries that are vital to routing your E-mail. In addition, in `comp.sources.unix`, `comp.sources.misc`, and `alt.sources`, you will find more free and public domain software than you'll know what to do with. There are other groups specifically for source code for machines such as the Sun and Macintosh.

Usenet works in a way that will seem strange to anyone who has ever used an electronic information service such as BIX. On BIX, you place a call to one central computer where the information is stored. On Usenet, your computer calls another and gets all the current news articles. Then, everyone on your machine can read the news. This means that the news passes from one machine to another, each adding new articles generated or collected at that site before passing it on. This also means that you will sometimes find yourself reading the answer to a question before you see the question. Usenet is distributed network anarchy at its best—or worst, depending on what is posted on any particular day.

In the next few columns, I'll discuss the practical matters involved in setting up UUCP and getting on the network, as well as how to obtain the public domain software necessary to make efficient use of the network. Also, there are more networks available to Unix users, with even more mail-addressing schemes. ■

David Fiedler is publisher of the Unix Video Quarterly *and the journal* Root, *as well as coauthor of the book* Unix System Administration. *He can be reached on BIX as "fiedler."*

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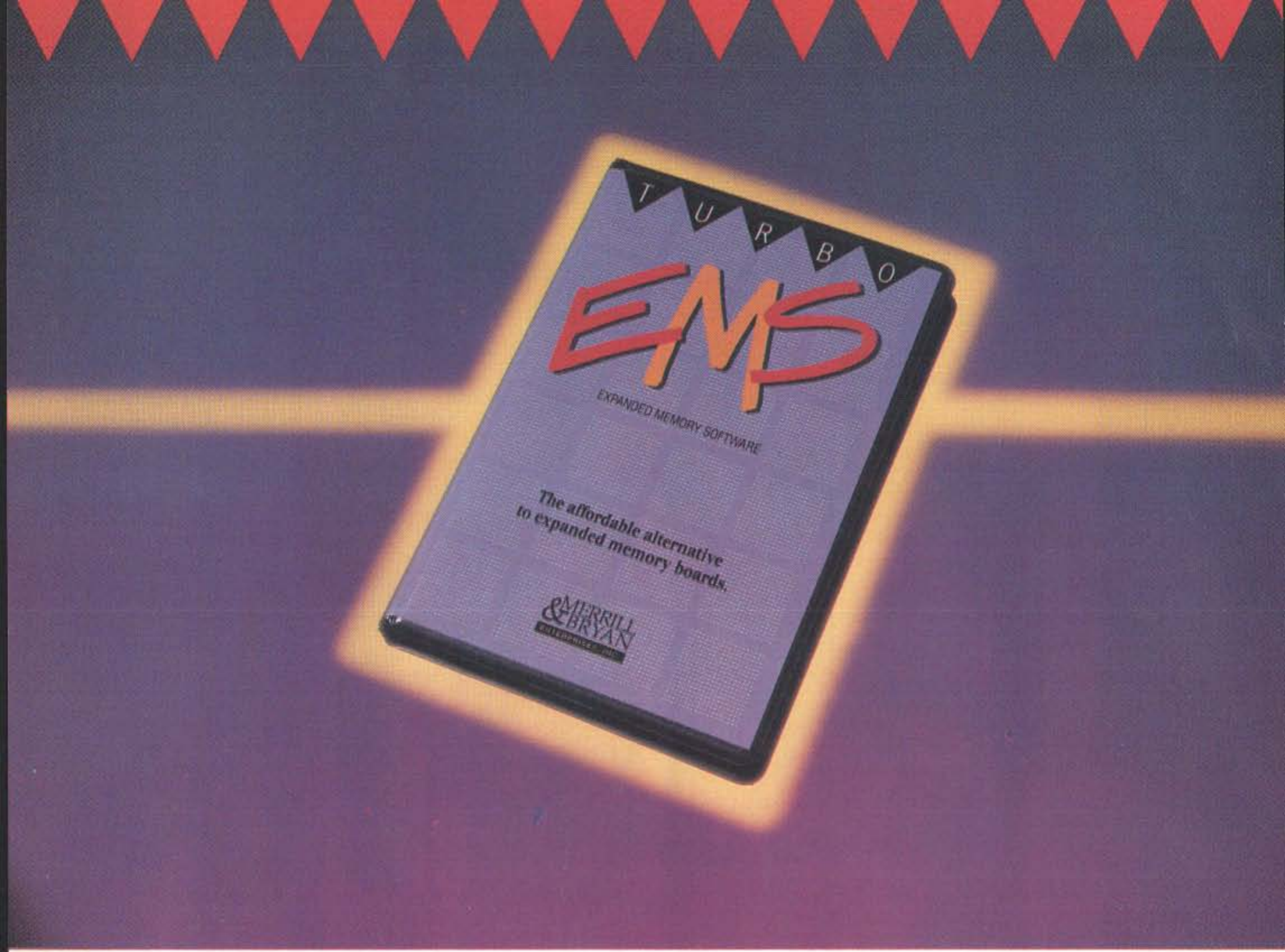
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DOWN TO BUSINESS ■ Wayne Rash Jr.

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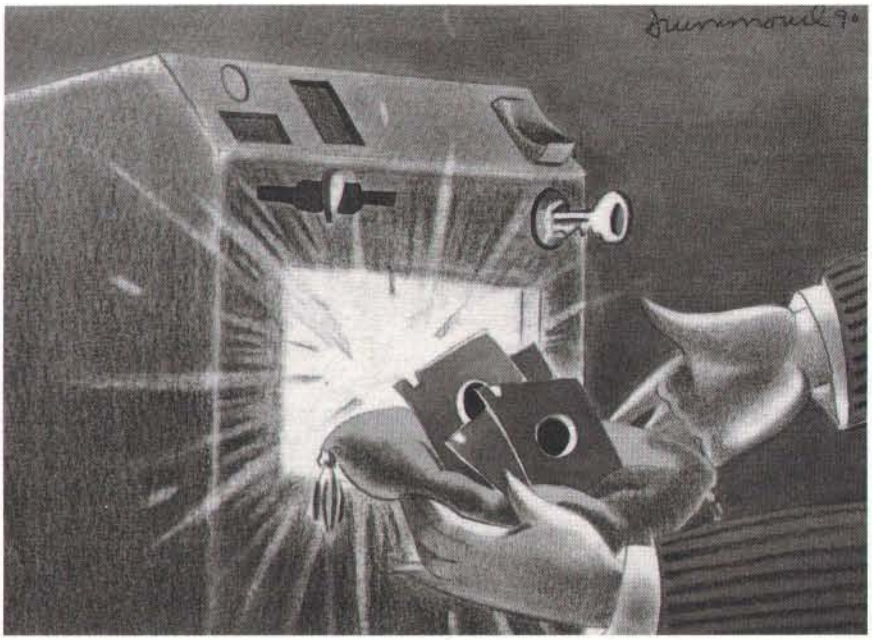

I could see the company vice president's concern as I spoke with him. He explained to me that the company had started out using only a centralized computer system on a VAX, but over the years had given its executives personal computers rather than terminals. The executives were able to produce reports using the superior tools available in the PC world, and to handle their financial responsibilities faster and with greater accuracy using tools like Lotus 1-2-3.

There was little indication that their information was being protected against loss. The executives left their reports and their spreadsheets on their hard disks and rarely backed up anything. Eventually, the computers began to age and their disks began to fail. Suddenly, the truth struck home.

A vast portion of the company's business was residing on a collection of aging $200 hard disks on computers spread all over the company. No longer was there a central repository for information. There was no way for the executives to be sure who had the latest copy of company-developed spreadsheet templates, nor any way for the company to ensure that everyone had the same version of important company data.

There was no doubt that information important to the company would be lost, for that had already happened. The question was when information *vital* to the company would be lost. Clearly, something had to be done.

Back to the VAX

The vice president had decided that a corporate LAN was the answer to the company's need. Individual departments or divisions bought file servers to support their employees. The employees were responsible for copying files to the server that needed to be backed up. Since the company was also installing network versions of WordPerfect and other software, most work stayed on the server anyway.

While most departments started to make it a practice to back up their data weekly, the company installed Novell NetWare for VMS on its VAX and began to back up the file servers on the company LAN to the VAX. The VAX was then backed up to tape by the computer room staff. Suddenly, corporate data was once again safe, software could be handled centrally, and one of the company's major assets, its data, was protected from loss.

But I Don't Own a VAX

Obviously, this was a large company with a professional data center, so it already had the personnel and financial resources necessary to handle this sort of project. But suppose you don't have a company with facilities this complete. Does this mean that you have to give up the idea of centralized data storage? In fact, it does not. There are ways to have all the benefits that this company had without investing in a VAX.

What is important is to realize the need to protect your information. While employees tend to think of the information on the computer assigned to them as "theirs," in fact it is not. It belongs to the company, and the company needs to make sure that it is protected against loss, improper alteration, or theft. One way to do that is to make data backup easy to accomplish so that your employees will do it.

continued

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They can make the process easier by backing up their data files to a file server on a LAN. This is as easy as copying a file to a place on the server where the LAN administrator will back it up for archiving. Alternatively, you can access each person's hard disk remotely and back it up through the LAN. Either way works, and you can use both ways if you really want to be safe.

Regardless of which way you choose to handle security, you need to pick a backup medium. You have a choice of several, including removable hard disks, optical disks, and tape. For most companies, the medium of choice for backups is tape. Tape is reasonably fast, reasonably inexpensive, and quite reliable. It's also a medium with which most people, even those with very limited computer experience, are comfortable.

You will have to choose a tape system designed to work in conjunction with a LAN, and you will have to find something that will be able to hold all the information to be backed up. A 40-megabyte tape drive won't be suitable for a LAN with a gigabyte of data. Finally, you'll have to make sure that the system you buy will support the type of backup you plan to do and the network operating software you plan to use.

ITEMS DISCUSSED

Filetalk	$495
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Inquiry 1102.

Planning Protection

Once you decide which way you're going to go, you need to develop a procedure to make sure that you keep your backups current. Most companies do this by making a complete system backup periodically (e.g., weekly or monthly) and then performing a backup every day of only those items that have changed. They keep enough tapes on hand to have one for each day of the week, plus a couple for the full system backups, which are usually stored in an off-site vault. These tapes are rotated less often.

How you rotate the tapes is not as important as the fact that you do, and that you actually back up the information. Backup is usually one of the assigned tasks of the LAN administrator. For this reason, it has a better chance of being accomplished than if you depend on the company executives to remember.

Deciding on the Approach

First, you have to decide on the amount of data you need to back up. Second, decide where this data will reside. Once you have made these decisions, you can pick the type and size of backup unit you want. Remember that you should plan to have one entire backup fit on a single tape or disk, unless you plan to have someone hang around all night to change tapes.

Tape drives suitable for backing up a company's data are available from a variety of sources, as are optical disks. Removable disk drives are rarely large enough to back up more than a small LAN, and they are probably not sufficient for an entire company, or even a

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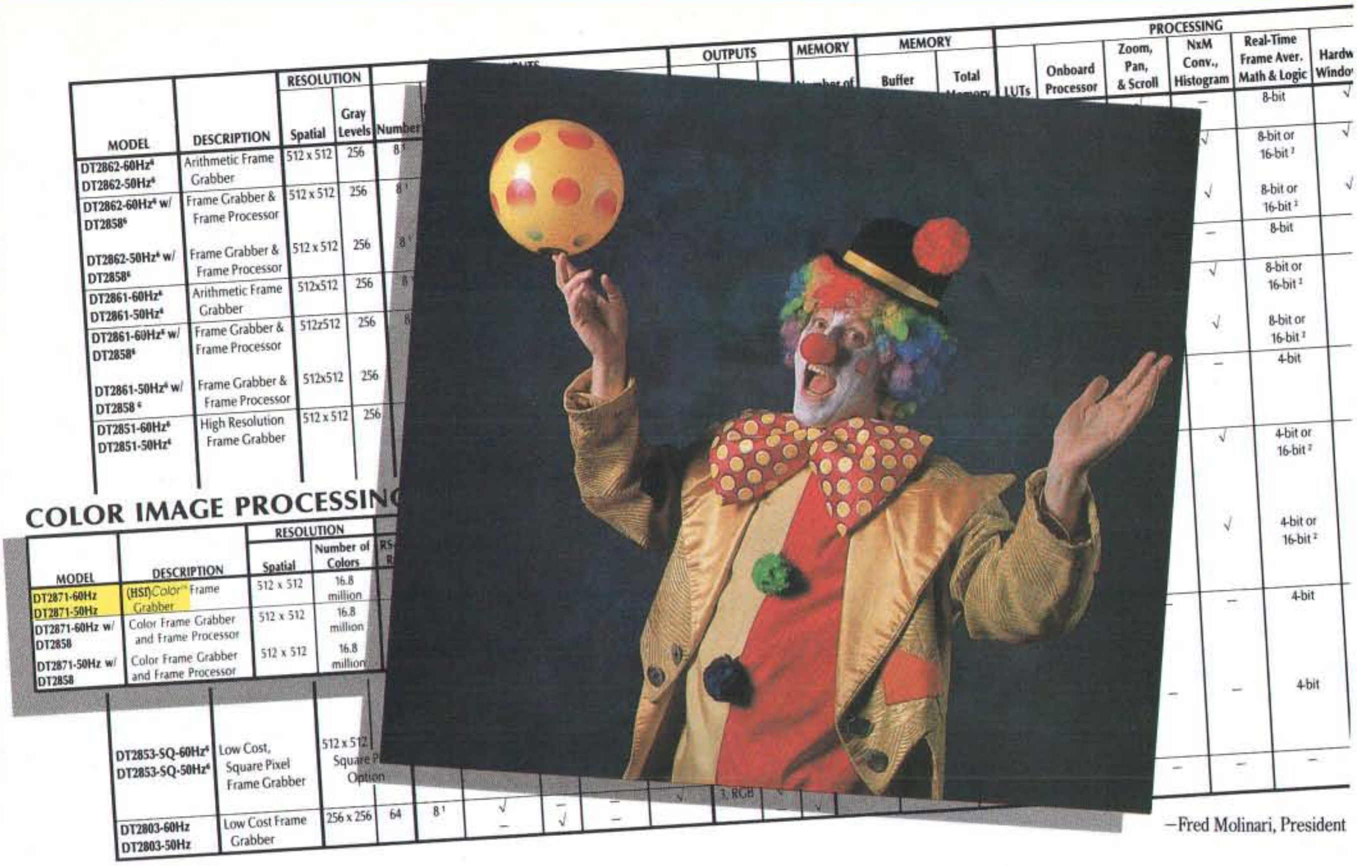

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DT2862-60Hz[6] w/ DT2858[6]	Frame Grabber & Frame Processor	512 x 512	256
DT2862-50Hz[6] w/ DT2858[6]	Frame Grabber & Frame Processor	512 x 512	256
DT2861-60Hz[6] DT2861-50Hz[6]	Arithmetic Frame Grabber	512x512	256
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department within a company. Optical disks of up to about 800 megabytes are available for personal computers.

As I mentioned earlier, though, most LAN backup takes place using tape drives. These drives range from about 150 megabytes at the lower end to 2.2 gigabytes at the upper end. Most departments can store all the data from their LANs in 2.2 gigabytes, although engineering shops that perform a lot of CAD work can create prodigious amounts of data. The tape drives that I looked at came from Mountain Computer, although many other vendors make these devices.

Mountain Computer makes a compact 2.2-gigabyte drive, its Series 2100, that uses 8-mm tape as the storage medium. It uses the same easy-to-use software as the smaller drives. For the most part, its tape units are shipped ready to run after installation.

One extremely useful software package that Mountain Computer ships is Filetalk. This package lets workstations on an IPX- or NetBIOS-based network operate in a peer-to-peer environment. This environment lets you back up remotely the hard disks of any workstation on the network. In fact, the software can be set up so that it will simply access the remote workstations one by one, copying each hard disk to tape before it proceeds to the next.

Because it operates in a peer-to-peer manner, Filetalk doesn't require the use of the file server. In fact, you can operate it with the file server turned off and torn apart as I did. Filetalk will also let you use the hard disk of the remote machine to do anything you can from your own. The only difference is that all software loads a little more slowly, since it has to come across the network.

This method probably gives you the ultimate solution to company-wide backups, assuming you have enough tape on hand. First you back up the file servers, and then you back up all the hard disks on the system. This method is sure to preserve the company data and protect the company from catastrophic loss of the information it depends on.

The way you choose to back up your company information depends on how your company operates and how it stores its data. You can, if you want, depend on each employee to remember and to take the time to do the backup. If you want to ensure backups really are being performed, you can use your LAN and have the network support the preservation of your company's records.

Before you decide that instituting reliable backup procedures is too hard or too expensive, ask yourself how much it would cost to replace the information stored on all the disks in your company offices. Then ask yourself whether or not you could replace the data at all, and if so, how long you could remain in business while you waited for the information to be replaced. ■

Wayne Rash Jr. is a contributing editor for BYTE and a member of the professional staff of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

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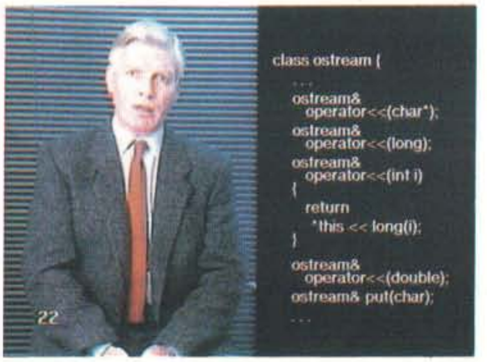

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   ostream&
     operator<<(long);
   ostream&
     operator<<(int i)
   {
     return
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   ostream& put(char);
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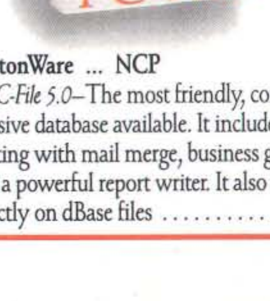

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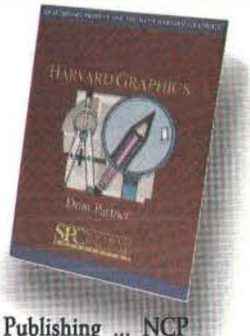

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	Quarterdeck ... NCP	
3221	☐Expanded Memory Mgr. 386 5.0	59.
3220	☐DESQView 2.25	79.
4586	☐DESQView 386 1.0	115.
6400	☐Manifest 1.0	39.
6422	☐QRAM 1.0	49.

Quarterdeck ... NCP
☐*Manifest 1.0*–Gives you a snapshot of your PC with detailed information about it's memory, hardware, DOS, and more. Included free with other listed Quarterdeck products through March 31, 1990 .... $39.

	Reference Software ... NCP	
4396	⊡Grammatik IV 1.0	52.
	Revolution Software ... NCP	
4480	⊡VGA Dimmer 2.01 *(screen saver)*	19.
	RightSoft ... NCP	
4155	⊡RightWriter 3.1	54.
	Samna ... NCP	
5799	⊡Ami Professional 1.0	319.
	Softlogic Solutions ... NCP	
3546	☐Disk Optimizer 4.05	45.
3542	☐Software Carousel 3.01	55.
	Softview ... NCP	
3474	🅁MacInTax for Windows *(1989 taxes)*	65.

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700B

MECA ... NCP
🅁*Andrew Tobias' Tax Cut*–Manage your taxes this year with MECA's new Tax Cut for '89. Includes expert system which lets you consult with the tax experts while you prepare your return. Editor's Choice! .... $45.

	Software Publishing ... NCP	
6289	⊡Draw Partner 1.0	59.
3499	☐PFS:First Publisher 2.1	89.
3478	☐PFS:First Choice 3.02	105.
3496	⊡Professional Write 2.11	149.
3493	⊡Professional File 2.01	199.
3482	☐Harvard Graphics 2.13	339.
	Symantec ... NCP	
5383	🅁Budget Express 1.0	99.
3427	⊡Q&A Write 1.01	139.
3425	☐Q&A 3.0	229.
3431	☐Timeline 3.0	399.
	Timeslips ... NCP	
2987	☐Timeslips III 3.4	169.
	Timeworks ... NCP	
6253	⊡Publish-It! 1.1	115.
	TOPS ... NCP	
3724	🅁NetPrint 2.0 *(share printers)*	125.
3726	🅁TOPS Network Bundle 3.0	159.
3720	*Flashcard 2.1 (AppleTalk network card; 1 year warranty)*	179.

Microsoft ... NCP
⊡*Excel for OS/2 1.0*–Spreadsheet which allows you to take full advantage of the power and flexibility of OS/2. Sophisticated analytical tools, easy-to-use Presentation Manager interface, and much more .... $339.

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DacEasy ... NCP

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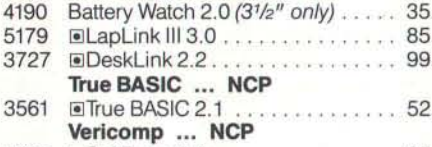
▣*Accounting 4.0*...................... $89.

☐*Rapid Tax 1.0 for 1989 Taxes*............. 45.

	Traveling Software ... NCP	
4190	Battery Watch 2.0 *(3½" only)*	35.
5179	▣LapLink III 3.0	85.
3727	▣DeskLink 2.2	99.
	True BASIC ... NCP	
3561	▣True BASIC 2.1	52.
	Vericomp ... NCP	
3765	▣SoftBytes 2.0	35.
	WordPerfect Corp. ... NCP	
3799	▣WordPerfect Library 2.0	75.
3804	☐WordPerfect 5.1	265.
3806	Additional Network Stations 5.1	169.
	WordStar USA ... NCP	
2825	☐WordStar Prof. Release 5.5	229.
5000	☐*Upgrade to Release 5.5*	89.
	Xerox ... NCP	
3812	☐Ventura Publisher 2.0	call
	XTREE ... NCP	
6161	▣XTREE Pro Gold 1.3	75.
	XYQUEST ... NCP	
4393	☐XyWrite III Plus 3.55	229.



Symantec ... NCP

☐*Q&A 3.0*–The top-rated, best-selling integrated database and word processor offers simple mail merge, detailed reporting, versatile word processing, advanced network support, and more........ $229.

RECREATIONAL/EDUCATIONAL

	Broderbund ... CP	
1417	☐Where/Europe Carmen Sandiego?	$29.
5701	☐Where/Time Carmen Sandiego?	32.
	Electronic Arts ... NCP	
5798	☐Ferrari Formula I	29.
4659	▣Chessmaster 2100 *(CP)*	35.
5804	▣Deluxe Paint II *(Enhanced)*	89.
	Microprose ... CP	
4454	☐F-19 Stealth Fighter	39.
5823	☐Red Storm Rising	39.
	Microsoft ... NCP	
2858	☐Flight Simulator 4.0	39.
	Parlor Software ... CP	
3159	☐Bridge Parlor 2.3	49.
	Sierra On-Line ... CP	
6023	▣Leisure Suit Larry III	39.
5695	▣Manhunter: San Francisco	33.
4456	▣Police Quest II	39.
5106	▣Space Quest III	36.
6022	▣Colonel's Bequest	36.

Stone & Associates ... NCP

▣*1st Math*–Animated graphics teach addition, subtraction, & patterning. Ages 4-8... $22.

☐*2nd Math*–Interactive tutorial and 7 games "teach" then "test" beginning addition through pre-calculus. Ages 7-16...... $27.

	Spectrum Holobyte ... NCP	
5993	▣Welltris *(Tetris sequel)*	22.
	Spinnaker ... CP	
5580	☐Sargon IV	32.
	Stone & Assoc. ... NCP	
3435	▣My Letters,Numbers,Words *(2 to 6)*	22.
3438	▣1st Math *(ages 5 to 8)*	22.
3439	☐2nd Math *(ages 7 to 16)*	27.
	Sublogic ... NCP	
6190	☐Air Transport Pilot	33.
	True BASIC, Inc. ... NCP	
	▣Kemeny/Kurtz Math Series: 10 titles	*each* 45.

HARDWARE

Manufacturer's standard limited warranty period for items shown is listed after each company name. Some products in their line may have different warranty periods.

Timeworks ... NCP

▣*Publish-It! 1.1*–This complete desktop publishing program includes advanced page layout, graphics, word processing, and typesetting...................... $115.

	AST Research ... 2 years	
1299	SixPakPlus 384k C/S/P	189.
4107	RAMpage Plus 286 512k	419.
	Brother International ... 1 year	
5787	HL-8e Laser Printer	1899.
5788	HL-8Ps PostScript Laser Printer	call
5786	Toner/Drum Kit	99.
	Central Point ... 1 year	
5042	Copy II PC Deluxe Option Board	115.
	Compucable ... 2 years	
1604	2-Position switch box	25.
1605	3-Position switch box	35.
	Corvus ... 1 year	
6184	ReadyNet Starter Kit	319.
6183	ReadyNet Add-On Kit	165.
	Cuesta ... 1 year	
1608	Datasaver 400 Watt *(power backup)*	429.
	Curtis ... lifetime	
1690	Diamond Plus SP-1 +	41.
1694	Emerald SP-2	36.
1707	Ruby SPF-2 *(6 outlets)*	55.
1708	Ruby-Plus SPF-2 Plus	65.
	We carry the full line of Curtis products.	
	Diconix ... 1 year	
5655	150 Plus Printer *(Parallel)*	359.
	Epson ... 1 year	
	We are an authorized Epson Service Center.	
1906	FX-850 *(80 col., 264 cps, 9 pin)*	369.
1904	FX-1050 *(136 col., 264 cps, 9 pin)*	479.
5183	LQ-510 *(80 col., 180 cps, 24 pin)*	349.
1930	LQ-850 *(80 col., 264 cps, 24 pin)*	549.
4117	LQ-950 *(110 col., 220 cps, 24 pin)*	569.
1917	LQ-1050 *(136 col., 264 cps, 24 pin)*	769.
4116	LQ-2550 *(136 col., 333 cps, 24 pin)*	989.
5184	LX-810 *(80 col., 180 cps, 9 pin)*	199.
1052	Printer-to-IBM cable *(6 feet)*	15.
	5th Generation ... 1 year	
3952	Logical Connection 512k	529.
	Hayes ... 2 years	
2304	Smartmodem 1200	289.
2307	Smartmodem 2400	429.
2308	Smartmodem 2400B *(w/Smartcom II)*	429.
	Hercules ... 2 years	
2318	Graphics Card Plus	189.

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It's important that we all keep our tootsies toasty as we stroll down the old stage road into the last decade of the 20th Century. So we're giving a free pair of genuine 100% wool PC Connection Sox to everyone who places an order of $500 or more between now and March 31.

Enjoy safe sox all winter long with warm and toasty 100% wool PC Connection Sox. Offer not available to accounts on net terms. One per customer.

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	-60 Meg Internal Tape Drive. . .	$379.
	0-60 Meg Int. Tape Drive for PS/2	379.
	83-152M Ext. Tape Drive.	759.
0	83-152M Int. Tape Drive	629.
153	DC2120 Cartridge *(5 pack)*	135.
190	DC2000 Pre-formatted Cartridges *ea.*	35.
	Pacific Rim ... 1 year	
5010	1.2 Meg External.	215.
5011	360k External 5¹/₄″ Drive	179.
	Plus Development ... 2 years	
3105	Hardcard 20 Meg *(49 ms)*.	529.
3106	Hardcard 40 Meg *(28 ms)*.	599.
6424	Hardcard II 80 Meg *(19 ms)*	699.
	Seagate ... 1 year	
	FREE PCTV® Hard Drive Installation Tape with purchase of 20, 30 or 40 Meg Seagate drive for the IBM PC (not for AT). Beta or VHS.	
2285	20 Meg Internal Hard Drive ST225 *(w/controller and cables, 65 ms)* . .	289.
2286	30 Meg Internal Hard Drive ST238 *(w/controller and cables, 65 ms)* . .	299.
4554	40 Meg Int. HD ST251-1 (28 ms) . .	359.
2287	40 Meg Int. HD for PC ST251-1 *(w/controller and cables, 28 ms)* . .	429.
4624	80 Meg Int. HD ST4096 (28 ms) . .	619.

XTREE ... NCP
▣ *XTREE Pro Gold 1.3*—A treasure of advanced disk management features—Directory Tree Display, Application Menus, Archive Management, Autoview & Enhanced View. Single keystroke commands for all operations . **$75.**

	TEAC ... 1 year	
4950	PC, XT 360k Drive *(5¹/₄″)*	79.
4951	720k Drive *(specify XT or AT, 3¹/₂″)* .	79.
4670	1.44 Meg Drive for XT *(3¹/₂″)*.	99.
4326	1.44 Meg Drive for AT *(includes Bastech software utilities, 3¹/₂″ copy prot.)* .	119.

MISCELLANEOUS

	Checkfree	
6360	CheckFree Xpress	25.
	CompuServe	
1676	CompuServe Information Service . .	24.
	Cables ... lifetime	
1019	Smartmodem-to-AT cable *(10 feet)* .	15.
5511	Right Angle Printer cable *(6 feet)* . . .	15.
1050	Parallel Printer cable *(15 feet)*	19.

DISKS

All disks have a lifetime warranty.

	5¹/₄″ DS/DD Disks *(360k)*	
3291	Sony *(10 disks per box)*	$12.
2789	Maxell MD2-D *(10 disks per box)* . . .	13.
4192	Verbatim Datalife *(10 disks per box)* .	13.
	5¹/₄″ DS/HD Disks *(1.2 Meg)*	
3770	Verbatim Datalife *(10 disks per box)* .	19.
3292	Sony *(10 disks per box)*	19.

Intel ... 5 years Samna ... NCP
Inboard 386/PC with Free Samna Ami—The Inboard 386/PC gives you 80386 processing power, and a free Samna Ami Windows-based word processor (regularly at $129). Offer good through March 31, 1990 . **$579.**

Practical Peripherals ... 5 years
2400SA MNP—Fully supports error-free MNP Level 5 data transmission, giving you more confidence in your communications. Also supports Hayes compatible 2400 bps standard operation. . . . . **$209.**

2790	Maxell MD2-HD *(10 disks per box)* .	19.
	3¹/₂″ DS/DD Diskettes *(720k)*	
3297	Sony *(10 disks per box)*	14.
3772	Verbatim *(10 disks per box)*	15.
2792	Maxell *(10 disks per box)*	15.
	3¹/₂″ DS/HD Diskettes *(1.44 Meg)*	
3298	Sony *(10 disks per box)*	29.
3773	Verbatim *(10 disks per box)*	29.
2793	Maxell *(10 disks per box)*	29.

MEMORY

3248	256k DRAMs *(120 nanosecond)* . . .	call
4366	1 Meg x 9 SIMMs *(100 nanosecond)*	call
5510	1 Meg x 9 SIMMs *(80 nanosecond)*	call
5746	1 Meg Chips *(80 nanosecond)*	call

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- If we must ship a partial order, we never charge freight on the shipment(s) that complete the order (in the U.S.).
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Peter Norton ... NCP
▣ *The Norton Backup 1.0*—Save your data before you lose it with the all new Norton Backup. 3 user modes for ease of operation at any level plus many more advanced features make your backups easy . . . . **$89.**

SHIPPING

Note: Accounts on net terms pay actual shipping.
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- For monitors, printers, Bernoulli Boxes, computers, hard drives, and power backups, pay actual charges. Call for UPS 2nd-Day & Next-Day-Air.
- For all other items, add $3 per order to cover UPS Shipping. For such items, we automatically use UPS 2nd-Day-Air at no extra charge if you are more than 2 days from us by UPS ground.

Hawaii:

- For monitors, printers, Bernoulli Boxes, computers, hard drives, and power backups, actual UPS Blue charge will be added. For all other items, add $3 per order.

Alaska and outside Continental US:

- Call 603/446-3383 for information.

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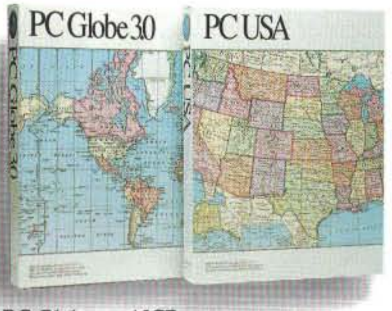

PC Globe ... NCP

☐*PC USA 1.0*–Instant profiles on all 50 states and Puerto Rico, including maps, graphics, and data . . . . $39.

☐*PC Globe 3.0*–Provides profiles of 177 countries. Exports to many popular programs. 39.

Intel ... 5 years

4696	2400B Internal Modem	159.
2352	2400B Internal Modem 2 *(for PS/2)*	249.
5119	2400 Baud External Modem	179.
6420	2400EX MNP Modem	229.
2346	Inboard 386/PC w/1 Meg *(w/free Ami)*	579.
2339	Inboard 386/AT *(req. inst. kit)*	859.
4266	Above Board Plus 512k	419.
4267	Above Board Plus I/O 512k	449.
5336	Above Board Plus 8 2 Meg	699.
5342	Above Board Plus 8 I/O 2 Meg	739.
4272	Above Board 2 Plus 512k	469.
5396	Above Board MC 32 0k	359.
4275	Connection Coprocessor	579.
4857	Visual Edge	449.
	MATH COPROCESSORS	
2370	80287-8 *(for 8 MHz 80286 CPU's)*	199.
2369	80287-10 *(for PS/2 Models 50 & 60)*	229.
4750	80387SX *(for 80386SX CPU's)*	309.
2371	80387 *(for 16 MHz 80386 CPU's)*	349.
2372	80387-20 *(for 20 MHz 80386 CPU's)*	399.

Kensington Microware ... 1 year

2582	Masterpiece Plus	109.
5697	Expert Mouse *(Trackball for PS/2)*	115.

Key tronic ... 3 years

4518	101 Plus Keyboard	99.

Kraft ... 5 years

5801	New Game Adapter *(2 game ports)*	27.
5800	3 button Thunder Joystick	29.
5802	Trackball	69.

Logitech ... limited lifetime

5464	Series 2 Mouse *(C9 for PS/2's)*	69.
5151	HiREZ Mouse *(C9)*	85.
6029	Trackman *(Trackball) serial* 85. *bus*	89.
4297	ScanMan Plus *(hand scanner)*	185.

Micron Technology ... 2 years

5818	Beyond 640 EMS Board 1 MB	369.
5821	Beyond EX Extended Mem. Brd. 2 MB	599.

Microsoft ... lifetime

2897	Mouse with Paintbrush	109.
2898	Mouse with Windows 286 2.1	139.

MicroSpeed ... 1 year

6007	PC-TRAC Trackball *serial* 75. *bus*	85.
6010	FastTRAP 3D Trackball *serial* 99. *bus*	109.

Mouse Systems ... lifetime

5845	White Mouse *(bus or serial)*	$69.
5997	Trackball *(1 yr. wrnty.) serial* 75. *bus*	85.
4306	PC Mouse II w/PC Paint+	89.

NEC ... 2 years

4799	Multisync 2A *(VGA Monitor)*	499.
5085	Multisync 3D Monitor	689.

Orchid Technologies ... 4 years

4690	ProDesigner VGA *(800 x 600)*	249.

PC Power & Cooling Sys. ... 1 yr

REPLACEMENT POWER SUPPLIES

3202	Turbo Cool 150 *(25° - 40° cooler)*	129.
3200	Silencer 150 *(84% noise reduction)*	115.

Practical Peripherals ... 5 years

3101	1200 Baud Internal Modem	69.
3100	1200 Baud External Modem *(mini)*	77.
3103	2400 Baud Internal Modem	139.
3102	2400 Baud External Modem	179.
5286	2400 Baud Int. MNP Modem *(Lev. 5)*	175.
5285	2400 Baud Ext. MNP Modem *(Lev. 5)*	209.
4542	2400 Baud Internal Modem for PS/2	229.

Intel ... 5 years

2400EX MNP Modem–MNP support allows error-free transmission as well as data compression providing 2400 bps throughput up to 4800 bps. Also supports Hayes compatible operation . . . . $229.

Safe Power Systems ... 2 years

4561	Safe 250W *(standby power bkup)*	249.
4562	Safe 425W *(standby power bkup)*	369.

SOTA Technology ... 2 years

5107	Floppy Drive Controller *(SS/p)*	99.
5111	SOTA 286i-12 *(12 MHz accelerator)*	269.
5402	SOTA 386i-16 *(16 MHz accelerator)*	389.

Targus ... lifetime

4899	Nylon Laptop carrying case	55.
6037	Premier leather carrying case	199.

TheComplete PC ... 2 years

5598	TheComplete Half Pg. Scanner 400	189.
4887	TheComplete FAX 9600	429.
5140	TheComplete Page Scanner	549.
5828	TheComplete Communicator	559.

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TOPS ... NCP

☐*Network Bundle for DOS 3.0*–Allows you to quickly and easily share files, electronic mail and printers between your Apple Macintosh, IBM PC and/or Sun Workstation. Now includes Inbox EMail software . . . . . $159.

Toshiba ... 1 year

3684	T1000 Laptop *(80C88, 6.4 lbs.)*	669.
4958	T1600 Laptop *(12 MHz, 20 Meg)*	3249.

Tripp Lite ... 2 years

6201	Isobar 8 *(8 outlets, 12 ft. cord)*	69.
6019	LS 600 Line Stabilizer	85.
6018	LC 1200 Line Conditioner	159.

Video 7 ... 7 years

5883	1024i VGA *(includes 512k)*	289.
4931	VRAM VGA 512k	449.

DRIVES

DTC ... 1 year

6248	AT Floppy/Hard Drive Controller	129.

IOMEGA ... 1 year

5116	Bernoulli II Single 44 Meg Internal	995.
5117	Bernoulli II Dual 44 Meg External	1969.
5113	44 Meg Cartridge Tripak *(5¼")*	249.
2499	PC2 Card *(controller required)*	169.
2500	PC2B Card *(bootable card)*	229.

Microlytics ... NCP

☐*GOfer 2.0*–The original, affordable, simple, painless, quick, easy, and fast text-retrieval software package for IBM PC and compatible computers . . . . $45.

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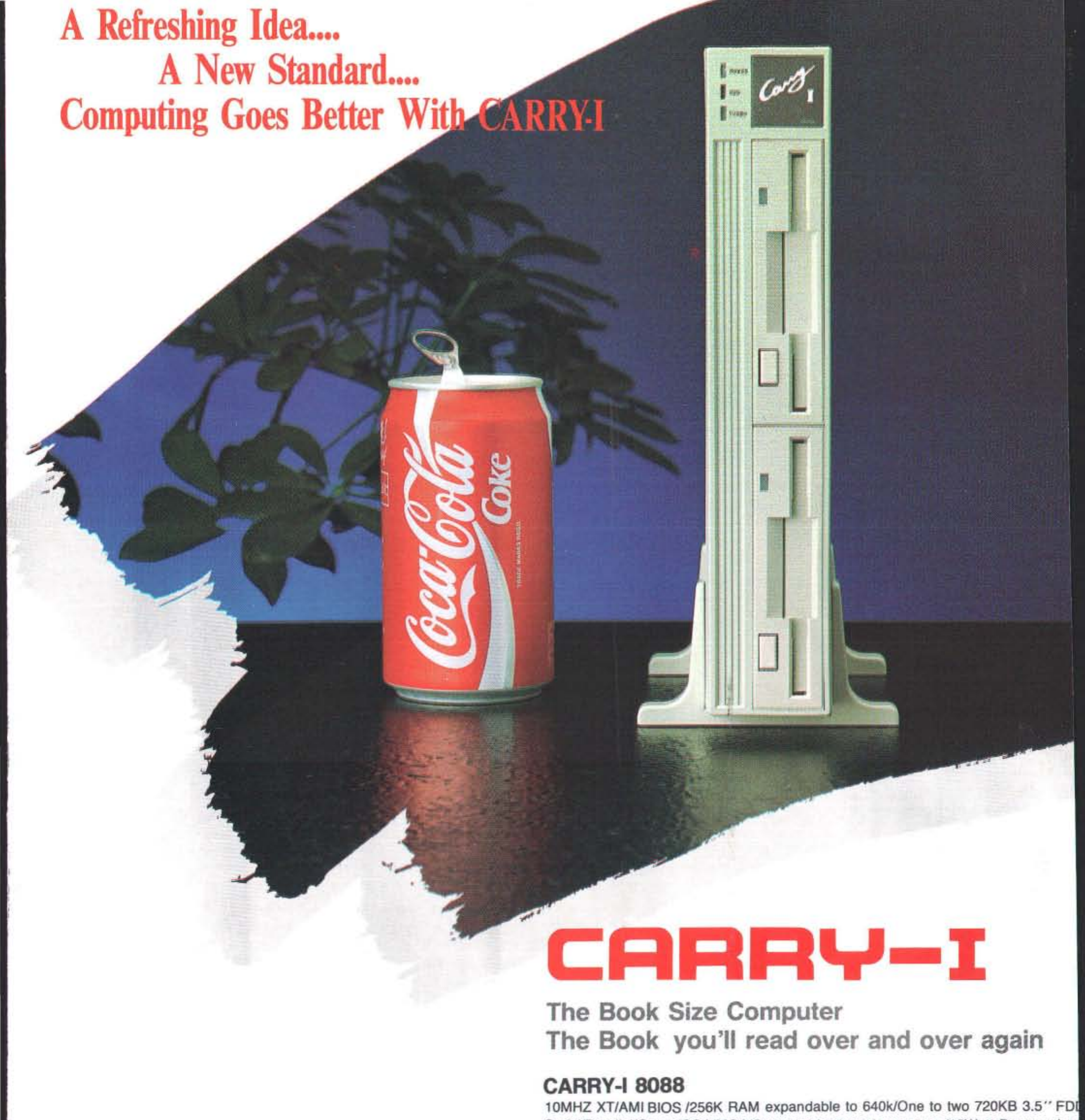

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CARRY-I 8088
10MHZ XT/AMI BIOS /256K RAM expandable to 640k/One to two 720KB 3.5" FD
Serial/Parallel/Game/CGA/MGA/Standard keyboard connector/16Watt Power adap
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CARRY-I 80286
12MHZ, 0 Wait State AT/AMI BIOS with Diagnostic/1MB RAM/20MB Hard Disk Drive optional/One to two 1.44MB 3.5" FDD/2 Serial/1 Parallel/CGA/MGA/Standar keyboard connector/30Watt Power adapter
Dimension: 240mm × 185mm × 45mm Weight: 2.1kg-2.8kg

CARRY-I KEYBOARD
82 Key/XT-AT Autoswitch
Dimension: 310mm × 145mm × 27mm

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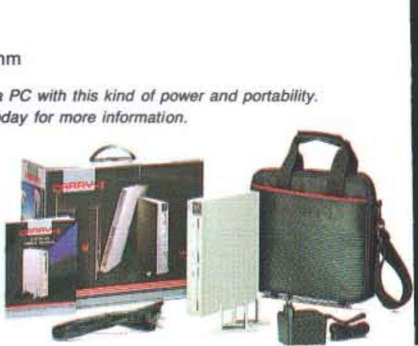

MACINATIONS ■ Don Crabb

A MAC MÉLANGE

A moral for Apple, and evaluations of a multimedia product and a font utility

Apple suffers from a serious disease. Not corporate malaise, whatever that is. Not bad fiscal management. Not even reorganizational plague (well, at least that disease shouldn't be fatal). No, Apple's real disease is the "not invented here" syndrome (or NIH for short). That is, if the software wasn't written at Apple, the company either is not interested in it or, worse, will implement a less practical way to do the same thing.

Apple has been suffering from this syndrome for years. Unfortunately, it's getting worse. And it's got to stop, or the Macintosh will eventually fade into the halls of computing obscurity now occupied by the likes of the Amiga and the Atari ST.

Murmurs the gentle reader, "OK, Don, what proof do you have of Apple's disease?" Simple: Apple loves proprietary system software. That's not my analysis, but a fact. The first Apple II didn't run CP/M, but Apple's own operating system. This proprietary seed fathered a whole series of proprietary operating systems for the Apple II, Apple III, Lisa, and Mac computers.

A/UX, which is Apple's Unix implementation, has been the company's one attempt to go with an industry-standard operating system. But even here, Apple has tried to wire in its own proprietary Mac Toolbox routines and graphical user interface, rather than relying on standard Unix device drivers and windowing systems, like the X Window System (although in a fit of sanity, the A/UX team has supported the X Window System and many other Unix basics).

While proprietary operating systems themselves aren't necessarily bad, this acute NIH syndrome has fostered unfortunate developments. The worst of these are those lawsuits designed to protect Apple's proprietary systems. Lawsuits are no substitute for innovation. The speed of technological development in the past 10 years proves that markets can't be stalled for the long term when innovation revolves around proprietary ideas. In short, proprietary software equals development stagnation.

Meanwhile, critical non-Apple connectivity products have still not been released. Where is Network File System (NFS) for the Mac? TCP/IP? DECnet? Where is. . . ?

If Apple doesn't snap out of this proprietary system software binge, the company will eventually be done in by cloners, who will succeed in spite of Apple's legal efforts. And Apple will get clobbered by other systems whose specifications are released to the public domain (like Sun did with NFS), where they can be incorporated into other software. That would be a shame.

Record the Screen with MediaTracks

Whatever you think of multimedia (and I think the concept has been overmarketed before it's been ready to stand on its own technical merits), there is no doubt that the Mac is the preeminent multimedia platform. More software and hardware accessories for the manipulation of digitized images, sound, music, full-motion video, animation, and the like exist for the Mac than for any other general computing platform. If you're interested in doing multimedia development work, the Mac is the machine that you should look at first.

One of the most talented companies

continued

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ITEMS DISCUSSED

Adobe Type Manager $99
Adobe Systems, Inc.
1585 Charleston Rd.
P.O. Box 7900
Mountain View, CA 94039
(800) 344-8335
Inquiry 981.

MediaTracks
(Price not yet set, but it's expected to be under $300.)
Farallon Computing, Inc.
2201 Dwight Way
Berkeley, CA 94704
(415) 849-2331
Inquiry 982.

trying to sell into this market is Farallon Computing. You may know the Farallon name from its twisted-pair AppleTalk networking products, but you should also know it from products such as ScreenRecorder and MacRecorder.

ScreenRecorder can record and play Mac screen events, but its capabilities are quite limited since it lacks basic video editing tools. It is useful for creating self-running demonstrations. Without editing tools, however, the demonstrations must be kept simple. MacRecorder, on the other hand, is a sound digitizer and editor that lets you capture sounds, including music, using its built-in microphone or a patch cord to another source, such as a compact disk player. Unlike ScreenRecorder, MacRecorder is quite flexible, letting you filter, edit, copy, and paste captured sounds.

To improve on ScreenRecorder and put some balance back between its two multimedia products, Farallon is releasing a program called MediaTracks. Unlike ScreenRecorder, MediaTracks is a real-time video editing system for editing "frames" of Mac images.

Essentially, MediaTracks works like an automated videotape editing system, the difference being that it records Mac screen images onto virtual "tapes" and edits them, rather than controlling an external video deck. These "tapes" can be chopped up into video clips and then reassembled in any order that you like. Thus, you can create some amazingly sophisticated moving images on the Mac's screen.

MediaTracks also allows you to adapt sounds that you've captured with MacRecorder (or other sound applications) and play them along with the images. The results are pretty impressive, even with the beta copy I've been testing. The program includes a set of draw tools, so you can annotate your video clips; you can also add some rudimentary programming functionality to a clip. This works much like the demonstrations or tutorials that you can build using WingZ and its built-in scripting language. MediaTracks is a good choice for creating interactive screen demonstrations or help systems.

Of course, MediaTracks won't cover the needs of everyone. First of all, it's not a full-motion video editor. It can't control external peripherals (e.g., videotape decks or laser disk players). It doesn't work with video frame grabbers, so its image source is strictly standard Mac screens. It lacks the video special effects that real videotape jockeys use all the time. While the first version of MediaTracks will lack these features, Farallon has every intention of incorporating many of these full-motion video features in a later release.

Its biggest limitation is that MediaTracks records only in black and white. You can paste color images from other applications, but that process is tedious if you plan to build a lengthy interactive screen session.

Since MediaTracks is still in beta testing, pricing hasn't been set (although MediaTracks should be out by the time you read this). Farallon expects to sell the system for less than $300. Bundled with MacRecorder and called Multimedia MediaTracks, the full system will cost a bit more.

Tip of the Month

In the past, I've reported on bugs, problems, and fixes for the System and important Mac applications. To keep this information current, I'm going to start giving reports on these problems every month, as much as space allows.

You've probably heard of the Adobe Type Manager. This new utility from the people who make PostScript purports to get rid of the jaggies when you display fonts on the screen and on dot-matrix printers like the Apple ImageWriter II. It does this by essentially bypassing QuickDraw. Once you install ATM in your System Folder (it's a cdev), it's loaded at start-up time.

ATM works by intercepting QuickDraw font calls to the screen or printer and replacing them with outline fonts. That is, ATM displays screen fonts using Adobe font outlines. Unlike the normal Mac screen fonts, which are bit maps, these outline fonts look crisp and clear at all sizes and on many output devices. I've used this utility for over a month now, and I've found some problems you should know about.

First of all, ATM can't fix the problem of "too few dots." On the ImageWriter II, for example, you are limited by its nine-pin print head and overall print density of less than 144 dots per inch. ATM can make large fonts (e.g., 72-point Helvetica) look good on an ImageWriter II because there are plenty of dots to work with. But smaller fonts, in the 10- to 18-point range, don't come out that much better than if the System had used QuickDraw and the old bit maps.

Second, ATM slows down your system. You can set its font cache to help overcome this, but I've found that unless you kick up the cache to 1 megabyte, the effect is minimal. Most Mac users don't have a megabyte of RAM to spare on a font cache.

Finally, ATM causes severe screen updating problems with some applications. Apart from its general slowness, ATM brings havoc to applications like Nisus, 4th Dimension, and WingZ. Screen updating is seriously impaired with ATM. You can even see the application stop the screen update while ATM sorts out the font details before continuing, which I find very annoying.

On the plus side, ATM displays or prints fonts (particularly at the large point sizes) without wasting megabytes of disk space for large bit-mapped font images. In PageMaker 3.0, it's handy for people who have to zero in on detail by displaying the page at the 200 percent setting and need the proper kerning for the text at this expanded scale.

As it stands now, I'd take a pass on ATM. Although it's inexpensive at $99, it introduces some quirks into formerly stable systems. Keep in mind, also, that Apple will be releasing its outline fonts as part of System 7.0. How ATM and Adobe's fonts work with System 7.0 is anyone's guess, but I do know that Apple is very protective of its system software. Remember where you heard it. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

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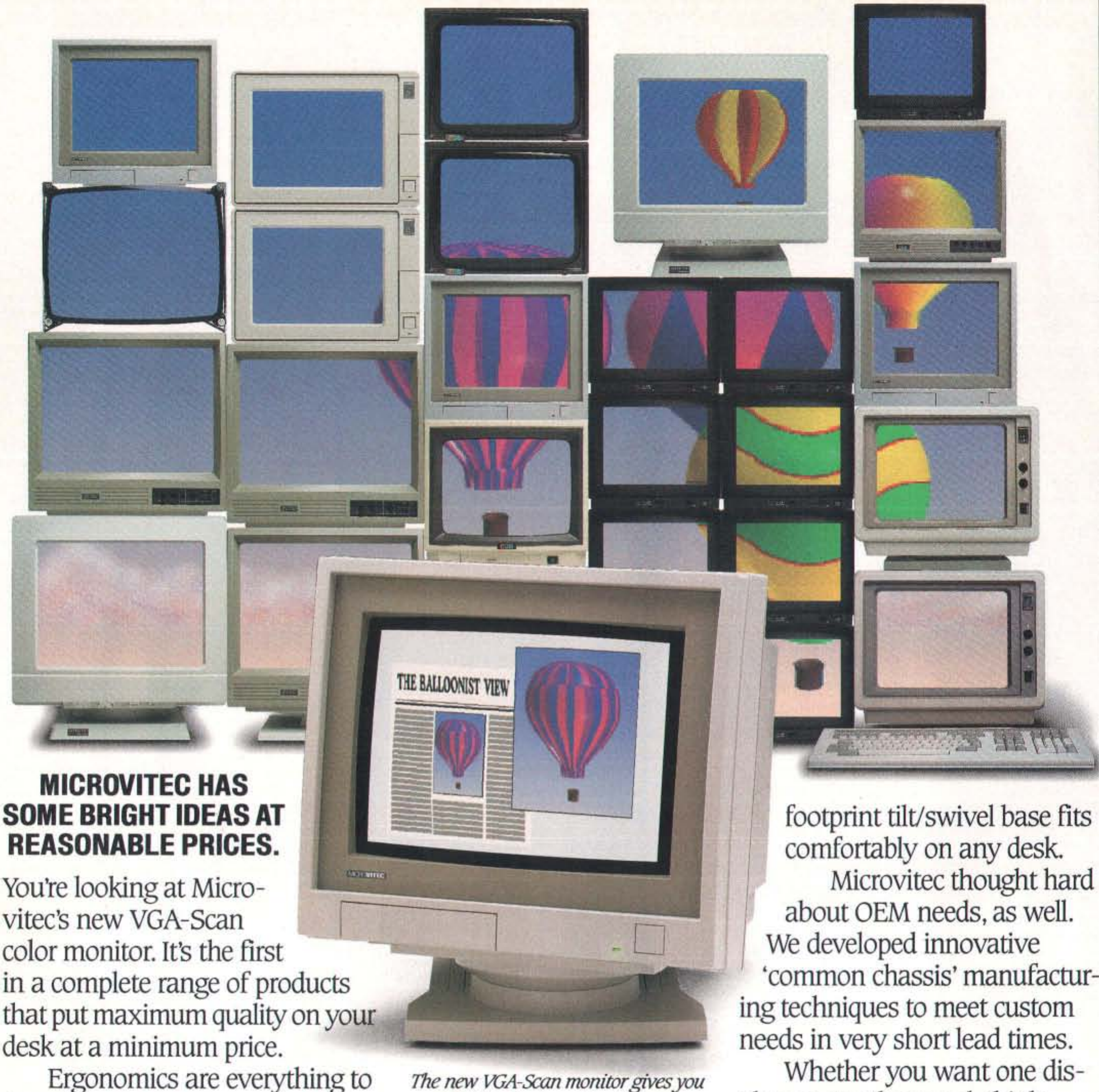

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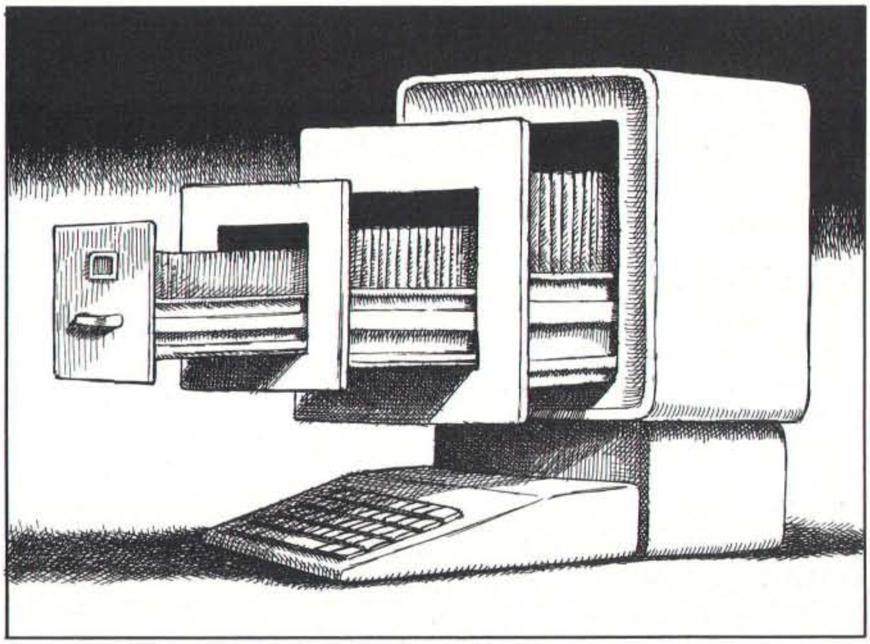
BRILLIANCE

OS/2 NOTEBOOK ■ Mark J. Minasi

TO HPFS OR NOT TO HPFS

How to use OS/2's High Performance File System without reformatting your boot-up disk



This is an early report detailing what I've found out about OS/2 1.2. In particular, I found out something that the manuals do not tell you about the new High Performance File System (HPFS). I want to share that with you and then move on to some other version 1.2 topics.

If you've read my previous columns, you know that the highlight of version 1.2 is the HPFS, which allows longer filenames, extended file attributes, and faster file access, for starters. However, version 1.2 seems to bring with it a dilemma: to HPFS or not to HPFS. The manual and the IBM support folks claim that in order to use HPFS, you

- must reformat your hard disk
- cannot use the dual-boot feature
- cannot access the hard disk under DOS

They're partly right: If you run the automatic installation program shipped with OS/2, it offers only the "HPFS or no HPFS" option. But there's a way around that limitation, assuming that you've previously partitioned your drive.

Using Partitions

If you don't know, you can, under DOS 3.3 and higher, divide a single physical drive into two partitions. The first one, called the C drive, is a *primary DOS partition*. Under DOS 3.3, the maximum size of this partition is 32 megabytes, and there is no minimum size. The remainder, no matter how large, can be given to an *extended DOS partition*, which is divided into logical drives, each no larger than 32 megabytes.

For example, one of my OS/2 workstations has an 80-megabyte drive. This drive is divided into a 32-megabyte primary DOS partition (the C drive) and a 48-megabyte extended DOS partition, which is further divided into logical drive D (32 megabytes) and logical drive E (16 megabytes). Two partitions, three logical drives. This is all accomplished with the DOS program FDISK or, under OS/2 1.2, the new program FDISKPM.

Before I leave the subject of drive partitions, here are two not-well-documented tidbits:

Tidbit 1: If you have two physical drives, the drive letters are not assigned intuitively. The primary DOS partition on physical drive 0 is named C. The extended DOS partition on physical drive 0 is then skipped for the moment, and the primary DOS partition on physical drive 1 gets the name D. Only then are the logical drives in the extended DOS partition of drive 0 used as drives E, F, or whatever. The drive letters finish up with the logical drives in the extended DOS partition in physical drive 1.

Tidbit 2: If your primary DOS partition is lost or erased, DOS or OS/2 can't access the extended DOS partition. If I took my partitioned 80-megabyte drive and reformatted C as, say, an HPFS partition, logical drives D and E would be untouched but unreadable to DOS.

How to Protect Partitions and Still Use HPFS

With those partition basics out of the way, it's now possible to explain what OS/2 1.2's installation program does to my 80-megabyte drive. The installation program asks whether or not to reformat the boot partition with HPFS. Since

continued

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reformatting the boot partition—the C drive, recall—eliminates what used to be the primary DOS partition (OS/2 primary partitions were identical to DOS primary partitions prior to version 1.2), the extended DOS partition containing drives D and E disappears also as far as DOS is concerned.

Thus, HPFS becomes an all-or-nothing proposition. That's kind of a pain, because the machine is then, as you've seen, committed to OS/2, and its drives are unreadable by DOS. The only alternative offered by the installation program and the OS/2 manual is to forgo the HPFS altogether. That's not satisfactory for many people. Thankfully, there's an (undocumented) third alternative.

The trick is to realize that HPFS volumes can be created *after* install time: The FORMAT command under OS/2 can format a logical drive to either HPFS or file allocation table format. The syntax `FORMAT d:/FS:FAT` creates a FAT-based volume, and `FORMAT d:/FS:HPFS` creates an HPFS-based volume. (In both cases, `d:` refers to a drive letter.) So tell OS/2 to install itself as a FAT-type volume on C *without* reformatting the drive. Then you can format one or more of the logical drives in the extended DOS partition—D, E, or whatever—as an HPFS volume, and then you have an HPFS drive to experiment with.

Before you can do that, however, there *is* one more catch. The CONFIG.SYS file requires the following line for HPFS support:

```
DEVICE=C:\OS2\HPFS.IFS -C:64
```

You won't find that line in your CONFIG.SYS file if you didn't tell the installation program to reformat the partition under HPFS. Add it to the CONFIG.SYS file, reboot, and you're ready to reformat a drive in the extended DOS partition as an HPFS drive. Of course, once you reboot under DOS, only the FAT-based logical drives will be visible to DOS. This will save you a lot of trouble, as this way you needn't clean off your hard disk prior to installing HPFS on your drive.

HPFS Performance Measurements

I know you're all wondering if the HPFS is, indeed, High Performance. Here are the results of a few quick-and-dirty tests.

First, I wanted to test how both file systems performed with fragmented files. The easiest way I know of to create fragmented files is to start with a simple one-line file—call it AB—and then COPY AB+AB CD and COPY CD+CD AB. Do the two COPY commands over and over until you get about a 3-megabyte file. I thought I'd try it on version 1.2.

To make the test as fair as possible, I partitioned a 30-megabyte drive into two 15-megabyte partitions: one HPFS, one FAT. I also installed a 64K-byte cache—the IBM default—on both the FAT and the HPFS partitions. Then I did the COPY commands to create the 3-megabyte file. Result: The HPFS partition took 41 seconds; the FAT partition took 38 seconds. Just for grins, I tried the test on the FAT partition again after booting under DOS: 26 seconds.

Ah, well, I thought, perhaps it's the COPY command. I decided to try a real-world application. I've been using Micrografx Designer in its beta version under OS/2 for a few months now, so I fired it up and loaded a drawing. The file is about 176K bytes, a fairly large drawing. I copied it to the HPFS partition and to the FAT partition, rebooted, and read the HPFS copy. Then I rebooted again and read the FAT copy.

The results were the same: The HPFS copy was a bit slower (53 seconds) than the FAT copy (43 seconds). Then I remembered that DOS handles disk partitions smaller than 16 megabytes differently than it does partitions larger than 16 megabytes, so I decided to get brave and reformat the 80-megabyte drive in the system.

When the FAT and HPFS partitions were each 32 megabytes, the story was a bit different. The COPY test took 31 seconds in the FAT partition and 28 seconds in the HPFS partition. The Designer test took 45 seconds in the FAT partition and 51 seconds in the HPFS partition.

Finally, I did a quick test of sequential and random reads. The sequential reads were identical for FAT and HPFS, but the random reads favored HPFS—1000 random reads took 12 seconds for the FAT-based partition but only 8 seconds for the HPFS-based partition. HPFS decreased by 33 percent the total read times.

So the initial results aren't exciting speedwise, save in the random access test. But the other features, like long filenames and extended attributes (which I discussed in January), have been long in coming, so it's nice to see them at last. ■

Mark J. Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

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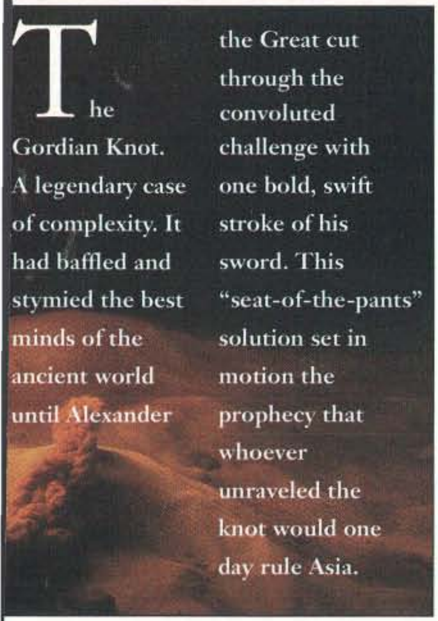

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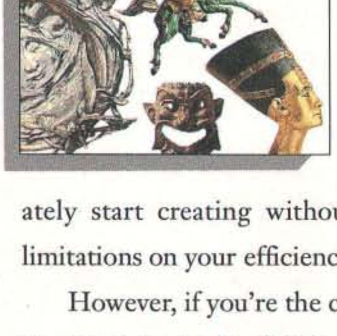

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Bill Catchings and Mark L. Van Name

SERVING THE POWER-HUNGRY

A new generation of servers brings minicomputer power to PC LANs

For several years now, buying a LAN server hasn't involved much thought. You put together a fast 80286 (or an 80386), a couple megabytes of memory, and a 150-megabyte hard disk drive, and you were in business.

But now that's changing. Server technology is improving in every way—and just in time.

Servers had to get better. Faster LAN hardware, such as the 16-megabit Token Ring, and an ever-increasing number of PCs per LAN are pushing current servers to their breaking points. And, as more data finds its way onto those LANs, reaching that breaking point becomes less tolerable. To solve these problems, server vendors are trying to increase the performance and reliability of every aspect of their machines.

Faster Processors

The most obvious improvements are in processor power. When the first 16-MHz 80386 systems hit the streets, they were speed demons. Today, anything less than a 25-MHz 80386 is a performance yawn.

The real action in servers is with the 33-MHz 80386 and the i486. Vendors like Samsung now offer 33-MHz flagship systems, and every vendor has either announced an i486 server or will soon. You can still use most of these new machines to run DOS, but they're best suited to the server life.

If that's not enough processing power for you, don't panic; multiple processors are on the way. Compaq's new Systempro, for example, can run with dual 80386 or i486 processors, and special versions of such network operating systems as NetWare 386 and LAN Manager will be able to take advantage of both CPUs. LAN Manager 2.0, for example, uses one processor for network functions and one for server applications, such as the Structured Query Language Server database manager.

More and Faster Memory

But faster processors alone are just not enough. They need memory that's fast enough to let them run without wait states. Because such DRAM is prohibitively expensive, vendors long ago turned to small caches of high-speed memory. That technology is now a standard part of most servers.

The amount of memory commonly available in those servers has increased dramatically. The main reason is the drop in memory prices in the last year. We recently reviewed an 80386SX system that offered an 8-megabyte upgrade for only $1100; about a year ago, we paid more than $400 for 1 megabyte.

Large system memory is particularly important for LANs with many users. Every client machine consumes some server memory for its current state, file locks, and so on. As the number of users increases, so, too, does the operating system's need for memory.

Intelligent Disk Drive Controllers

Intelligent disk drive controllers can also take advantage of extra memory for onboard caches. Controllers with caches of 4 megabytes or more are increasingly common, and they yield large performance gains. Many high-performance servers now use the popular Distributed Processing Technology (DPT) and Konan caching controllers with 4- to 8-megabyte caches. The hyperSTORE-1600 controller from Perceptive Solutions can

continued

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have a cache as large as 20 megabytes.

Faster controllers become important as disk traffic increases. The best main processor in the world is no good if so many users are making disk requests simultaneously that the controller can't keep up. These intelligent controllers can bring average access times down from the range of tens of milliseconds to hundreds of nanoseconds—so individual users get what they want faster, and more users can get to the disk per unit of time.

Faster and Bigger Disks

The disks themselves are also faster and bigger than ever. Drives with average access times of less than 20 ms are common, and you now can get drives with average access times of 10 ms or less.

While access times are dropping, capacities are increasing. As more users store more data on their servers, a system with a single 300-megabyte hard disk drive is no longer a big server. Our 150-megabyte server disk filled up far faster than we ever anticipated.

Now coming to the rescue are servers whose drives dwarf ours. The Seattle-based Mission Cyrus Group, for example, has a server whose base configuration includes a single 720-megabyte hard disk drive. Further, it has the drive bay and power supply capacity for four of those drives—2.8 gigabytes of hard disk.

In a few years, even that amount will be unimpressive, as erasable optical disks and WORM (write once, read many times) disk drives become more common on servers. Intelligent controllers can greatly improve the normally anemic performance of these devices.

Hard disk subsystems are also becoming more reliable. The Mission Cyrus server included an uninterruptible power supply as standard equipment. Some vendors are selling drives in matched pairs designed to support disk mirroring (a technique in which the server uses one disk drive as an ongoing exact duplicate of the other).

Sum of the Parts

When you put all these fast technologies together in a typical AT clone, you still have only a very fast, very high-capacity AT. Even that's beginning to change. These new servers are becoming minicomputers in PC-size cases—and the cases are growing, too. (Many minicomputer vendors started offering similar small cases several years ago.)

One key aspect of this change is the system's bus. Servers are rapidly becoming the biggest battleground in the war of Micro Channel architecture versus Industry Standard Architecture (ISA) versus Extended Industry Standard Architecture (EISA). The main issue is the ability to support bus-master cards. Without such boards, the processor must spend cycles on work better suited to a disk drive controller or network adapter.

It's possible to build bus-master cards on an ISA (AT-architecture) bus. A few vendors, including Racal (in its InterLAN), already offer ISA bus-master network adapters. Still, the ISA bus wasn't designed to support such cards. Some systems just won't work with these cards, and others experience intermittent problems. Further, because there's no standard ISA protocol for bus-master cards, multiple bus masters in a single system are likely to collide.

Both Micro Channel and EISA, by contrast, were designed with bus-master

continued

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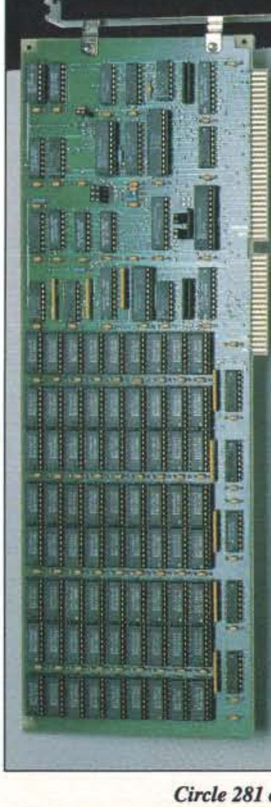

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DESIGN PHILOSOPHY
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MEMORY
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- Split Memory Addressing allows the user to fill out conventional memory to 640K.
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Circle 8 on Reader Service Card

cards in mind. A system with a fast processor, lots of memory, and intelligent bus-master LAN and disk drive controller cards would be a real screamer.

Enter the Systempro

Compaq's Systempro provides a glimpse at the future of server technology. It can hold either one or two processor boards, each of which can sport a 33-MHz Intel 80386 or i486. It can contain up to 256 megabytes of memory. (We recently saw an over-$20,000 32-megabyte Systempro card that was less than 6 inches long.)

The Systempro couples its processors and potentially vast memory with a 32-bit EISA bus. Its bus-master disk drive controller can handle four drive arrays of two 210-megabyte drives each, for a total of 1.6 gigabytes of hard disk storage. The controller can also use the drive pairs for disk mirroring.

Compaq claims that the Systempro can support six bus-master LAN cards running at full speed and still have some cycles left. We're leery of such claims, but a recent Novell demonstration gave this one some credence. It showed a single Systempro that was serving 250 PCs. If you've ever used a NetWare server with 40 or 50 clients, you know just how impressive this demonstration was.

Don't plan to put a tricked-out Systempro in your house soon, however. For one thing, it would be a waste of money to use it as a DOS system. DOS can barely figure out what to do with one i486, let alone two. And you can spend upwards of $200,000 if you go for all the options.

Sounds like a minicomputer's price, doesn't it? It should. The Systempro is, for all practical purposes, a minicomputer. Even Compaq is aware of that fact, although the firm might be slow to admit it. For example, when it came time to benchmark the Systempro, Compaq chose Digital Equipment's VAX and the Hewlett-Packard 9000 Series minicomputers.

Those industry pundits who said that PC LANs would replace minicomputers were half right. PC LANs probably will, but at their heart will be minicomputer-size servers in PC cases.

Riding the Curve

It almost had to happen. PCs are following the same development curve as the minicomputers and mainframes before them, but at a much faster pace. They started as slow single-process computers. They grew in power and capacity as they shrank in size. Faster processors led to faster memory, then to memory caches, and then to multiple processors.

We're now nearing the same point in the development cycle as mainframes and minicomputers. When our PC LAN servers have reached the same stage of multiprocessor technology as their bigger cousins, large performance gains will be much harder to achieve.

Fortunately, until we reach that point, there will always be a hot new server just around the corner. We'll try to keep you abreast of those developments. ■

Bill Catchings and Mark L. Van Name are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "wbc3" and "mvanname," respectively.

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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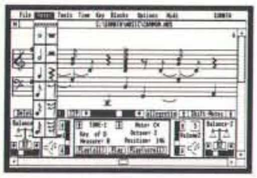

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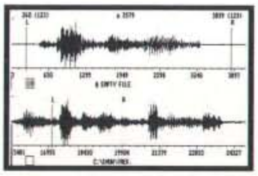

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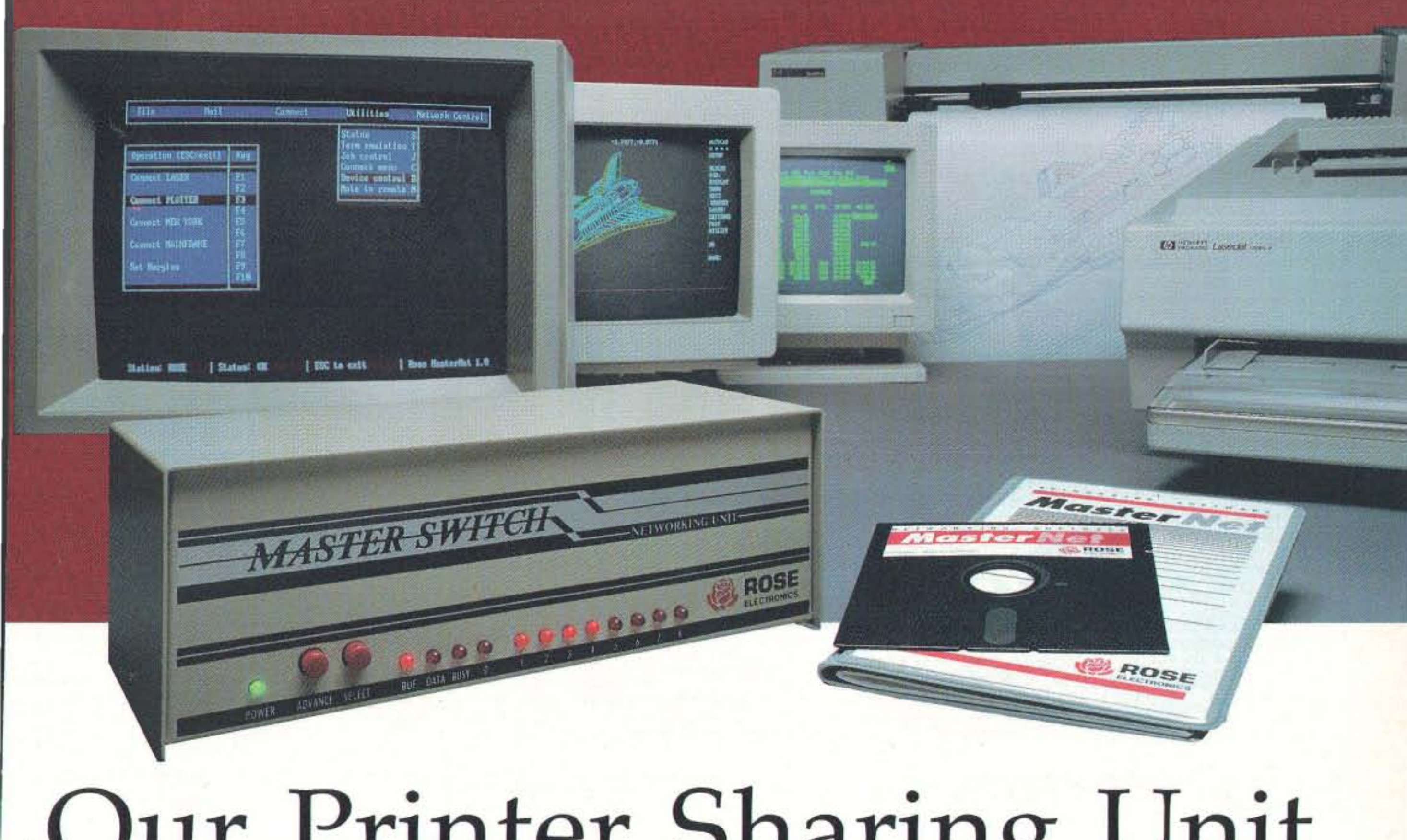

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SHORT TAKES

BYTE editors' hands-on views of new and developing products

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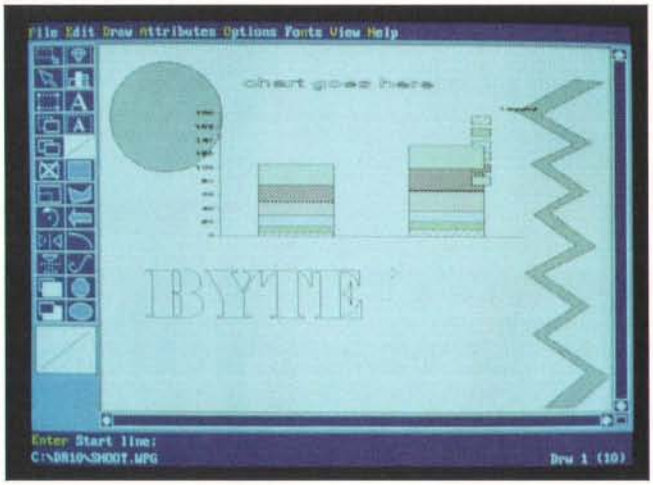


WordPerfect's Graphics Companion

WordPerfect Corp. designed **DrawPerfect** as the graphical "better half" of WordPerfect 5.0. However, an early look at prerelease version 1.0 indicates that DrawPerfect could also stand on its own as a presentation graphics program.

The connection with WordPerfect is built into DrawPerfect. Using a software component called the Shell, you can switch back and forth between the word processor and the drawing program with one keystroke. If you've got enough memory in your system, you can keep both programs running, making it easy to hop from a docum—ent to the drawing board; work on an image, chart, or figure; and hop back to the text and quickly place the image on the page. If you do any kind of work involving text and graphics, you know this sure beats what can seem like an endless shutting down and firing up of applications. You can also keep DrawPerfect running while you switch to another DOS application.

DrawPerfect itself takes up 384K bytes of memory, which is remarkably spare when you consider the capabilities of the program.

DrawPerfect produces vector, not bit-mapped, graphics, so you're working with objects instead of pixels, creating images by defining beginning, ending, and joining points. The program's toolkit, represented by large icons on the left side of the screen or embedded in menus along the top, includes the type of tools you'd find in, say, Adobe Illustrator or Aldus FreeHand: functions for quickly generating lines, squares, circles, curves, ellipses, arcs, and polygons.

After you've drawn an object, it's easy to manipulate it in certain ways, such as changing its shape, size, or orientation (although in some instances you have to first select the Modify command, which I found easy to forget).

The one thing you can't do is go in and manipulate just a bit of an object, because this type of program treats each object as a solid entity; if you're crossing over from a paint package, you might keep looking to grab the eraser.

Besides the shape-making and object-editing tools, DrawPerfect has text-rendering functions. The program comes with 25 "base" fonts, from the commonplace (e.g., Helvetica and Courier) to display typefaces (e.g., Old English and others called Brushscript and Hobo). The program will scale these fonts from very small to very large; I set text in sizes ranging from 6 points up to 130 points and thought the printed output looked fine and crisp.

As part of its role as a presentation graphics package, DrawPerfect has capabilities for making bar and pie charts. More sophisticated charting programs are available, but you won't find a more accessible means of incorporating this kind of visual data.

DrawPerfect images are not limited to use only in WordPerfect documents. Although .WPG is their native format, they can be pulled in by any program that works with CGM (Computer Graphics Metafile) and HPGL (Hewlett-Packard Graphics Language) files. You can send the output to just about any dot-matrix or laser printer (the list of supported printers runs on for several screens), film recorder, plotter, or a slide bureau.

This program is about as easy to use as it could be. I had it up and running (on a BitWise 386) in a few minutes, without a hitch. The installation program is painless. If something doesn't make sense, the help menu or the documentation will clarify it. The prerelease manual even took time to explain what boxes and circles are.

Although the images on the screen looked a bit rough and ragged, the printed output was slick and sharp, with that familiar Illustrator/FreeHand look. I must confess I didn't expect to be impressed by this program. A drawing package from a word processor company? That's like the Boston Pops trying to play the blues. But it's not, really. WordPerfect Corp. made its name in the world of words. Now it has a chance to do the same in the world of images.

—D. Barker

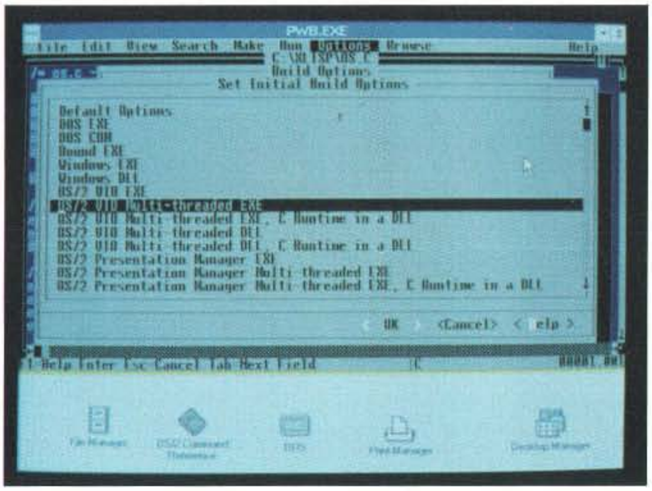
THE FACTS

DrawPerfect
$495

Requirements:
IBM AT or compatible with two 720K-byte floppy disk drives or a hard disk drive and a graphics display; the program takes up 384K bytes; a mouse is recommended but not required; it works with WordPerfect 5.0 or higher.

WordPerfect Corp.
1555 N. Technology Way
Orem, UT 84057
(801) 222-5000
Inquiry 988.

Microsoft C 6.0 Weighs In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The newest Microsoft C compiler doesn't do C++, as many industry watchers thought (and hoped) it would. Instead, Microsoft has wisely chosen to consolidate and refine the set of tools that C programmers need to write software for DOS, Windows, and OS/2. The new tools in **Microsoft C 6.0** include quick and optimizing compilers for both DOS and OS/2, CodeView 3.0 for DOS and OS/2, and a Xenix-derived Make. You can deploy these from the command line or from within a new integrated environment called the Programmer's Workbench. The Workbench runs identically under DOS and OS/2, with a character-mode graphical user interface, in the style of Microsoft's "Quick" languages.

The list of target environments includes DOS command (.COM) and executable (.EXE) files, Windows .EXE and dynamic link library (.DLL) files, and OS/2 single-threaded and multithreaded .EXE and .DLL files, in both Presentation Manager and non-PM flavors, with embedded or external (DLL-style) run-time libraries. Yikes! No wonder the installation—for just the small memory model—ate up 10 megabytes of my disk space.

The Workbench makes a programmer's life easier in a couple of ways. For starters, it derives Make scripts from a list of sources (i.e., .C, .H, .RC, and .DEF files). The Set Dependencies option looks for `#include` statements—transitively—and adds the referents to the script's list of triggers. Information collected from Workbench dialog boxes boils down to compile and link switches in the make file, so you don't have to remember (or, more likely, cut and paste) incantations like `cl -c -Asnd -G2sc -Od -W3 -Zip`.

Once you've got a baseline compile under your belt, the quick (incremental) compiler really speeds up a large project. But the niftiest new feature is the Browse tool. Given a program symbol (i.e., a variable, function, type, or macro), you can answer questions like, "Where was this symbol defined?" and "Where is it used?" In the case of a function, you can also answer the questions "What functions call it?" and "What functions does it call?"

The compiler itself builds the Browse database. In order to do its job, an optimizing compiler builds an elaborate representation of a program's structure. Recycling that information for the programmer's use is a great idea. Of course, the technique requires a successful initial compilation. I wanted to investigate an include-file clash between OS/2 and an application I was testing, but—catch-22—the compilation failed, so I couldn't use Browse to find out why. Once you get rolling on a project, though, Browse quickly becomes indispensable.

A more powerful optimizer works on entire functions. The new 16-bit-based pointer behaves like a far (32-bit) pointer, by relying on an implied base segment. New optimizations include register allocation based on an analysis of entire functions and the ability to pass parameters in the registers.

CodeView's data inspector has improved, and you can now run the DOS version of the debugger in extended memory on an 80286 or 80386. Extensive on-line help pops up from within every tool.

No other programming system so comprehensively attacks all the Microsoft environments. Professionals who target those environments will doubtless come to rely on Microsoft C 6.0. Make no mistake, though, it's a world of its own. A great place to live, perhaps, but a difficult one to visit.

—Jon Udell

THE FACTS

Microsoft C 6.0
$495

Requirements:
IBM PC or compatible running DOS 3.0 or OS/2 1.1 or higher with at least 512K bytes of RAM and a hard disk drive with 8 megabytes of free space. Microsoft recommends at least an 8-MHz 80286 with 1 megabyte of RAM or 4 megabytes for OS/2.

Microsoft Corp.
16011 Northeast 36th Way
P.O. Box 97017
Redmond, WA 98073
(206) 882-8080
Inquiry 989.

A Slightly Different Laser Printer

When is a laser printer not a laser printer? When it's a new low-price compact LED printer from Okidata. The new **OkiLaser 400** is very similar to a standard laser printer except that it's smaller and less expensive. And one other thing: It doesn't happen to use a laser.

How does it print? The OkiLaser is the latest of a small group of page printers that use a simple linear array of LEDs rather than a laser to produce a print image. The advantage of the LED is that it allows the printer manufacturer to use a much more simple and reliable design.

In a standard laser printer, a complex system of lenses and moving mirrors causes a laser beam to scan across a rotating light-sensitive drum located inside the printer. In fact, the laser beam must scan the length of the drum hun-

continued

dreds of times per second.

In an LED printer, the array is approximately 8½ inches long, and it consists of two rows of 1270 LEDs that are offset with each other, yielding a total of 2540 pixels at a density of 300 dots per inch. The LED array remains slower than what I expected. In graphics, it was a little faster.

One of the advantages of this printer is its assortment of extra fonts. A total of 21 fonts are resident, including a 14-point Helvetica and a set of 10-point Roman faces. Four of the fonts are in landscape mode. The printer is compatible with LaserJet downloadable fonts and with Hewlett-Packard-compatible software.

THE FACTS

OkiLaser 400
$1395

Requirements:
Personal computer with parallel or serial interface.

Okidata
532 Fellowship Rd.
Mount Laurel, NJ 08054
(609) 235-2600
Inquiry 990.

As in a few other printers, the OkiLaser's toner and print drum are separate units, so you can replace toner without having to replace the expensive drum. However, I found that installation of the drum and the toner can be a bit tricky.

If you want laser-quality output without going into major debt and without giving up the air rights over your desk, the OkiLaser 400 may be an excellent choice. The LaserJet IIP will give it strong competition—and rightly so. But the OkiLaser uses much more interesting technology.

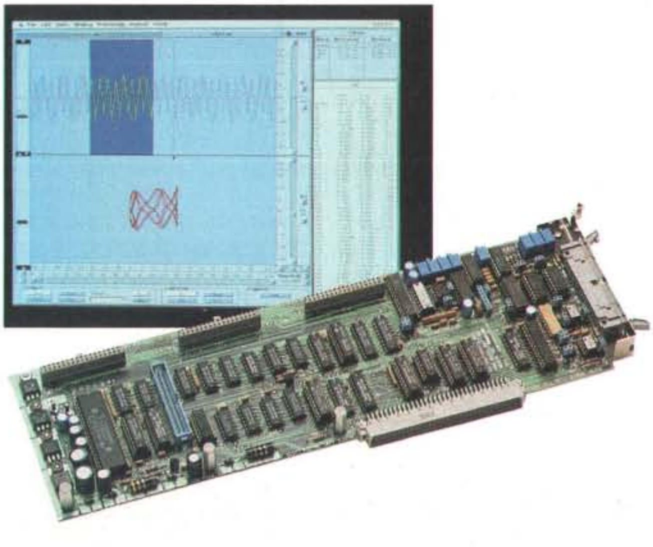
—Rich Malloy

Data Acquisition as Easy as a Mac

Data acquisition is never a pretty sight. There are wires to run, connections to make, and sensors to calibrate. Then there has to be a way to store and examine all the data these sensors serve up. A microcomputer is a cost-effective means of serving as both a data acquisition and data storage device—as long as you can figure out how to use the software. GW Instruments, maker of MacAdios data acquisition boards for the Macintosh, realized that simply buying the board wasn't enough: You had to be able to use it. Ideally, you want a program that converses with the boards, displays the captured data in a meaningful form, and then saves the data.

The result of GW Instruments' work is **SuperScope,** a Mac application that presents analog or digital measurements from their data acquisition boards as waveforms on a "virtual" oscilloscope front panel, with options to save this data to disk. Since scientists and engineers often work with an oscilloscope, they will be able to make use of SuperScope's capabilities immediately.

SuperScope can display up to eight oscilloscope-type windows, with each window showing up to eight waveforms. Each waveform is labeled with a unique name and is color-coded for easy identification. Waveforms can be plotted versus time, frequency, or other signals.



THE FACTS

SuperScope
$990

Requirements:
Mac Plus, SE, or II family with 1 megabyte of RAM, running System 4.2 or higher.

GW Instruments
35 Medford St.
Somerville, MA 02143
(617) 625-4096
Inquiry 991.

Like many Mac applications, SuperScope makes extensive use of the computer's cut, copy, and paste capabilities. You can select a portion of the waveform in the oscilloscope window by clicking and dragging, and then cut or copy the highlighted area to the Clipboard. Menu selections under the Wave menu let you select a signal by name and copy it to the Clipboard, either as a graphic or as a list of text data points.

You can also direct measurements to journal files, which save the captured data as text in formats for export to either spreadsheets or word processors.

SuperScope uses a modular approach to software design, so you can control peripheral devices from within it. Extensive documentation, software libraries, and source code are available for writing your own custom processing modules. GW Instruments supplies modules for pulse analysis, delay processing, and data transfer to and from disk. Modules to control GW's time-stamping board, IEEE-488 boards, and GW's function generator are

continued

Embedded systems designers have already used **CrossCode C** *in over 577 different applications.*

CrossCode C comes with four powerful tools to help you program your 68000-based ROMable applications

From C source to final object, each tool takes you one step closer to your finished ROMable design

CrossCode C is designed specifically to help you write ROMable code for all members of the Motorola 68000 family. Four powerful tools take you from C source to object code:

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- Compiler output code is split into five independent memory sections that you can assign into ROM or RAM as you please.
- You can optimize the code for your application because *you* control the sizes of data types. For example, you can optimize for speed by using two byte *ints*, or get maximum versatility by using four byte *ints*.
- You can easily write assembly language routines that call C functions and vice versa, because the compiler uses simple, well documented parameter passing conventions.

2. ASSEMBLER: CrossCode C comes with a Motorola-style assembler that has all the features that assembly language programmers require. In fact, you could write your whole application with it:

- The assembler features an advanced macro language, conditional assembly, "include" files, and an unlimited size symbol table.
- Detailed cross references show you where you've defined and referenced your symbols.
- After a link, you can actually convert your "relocatable" assembler listings into "absolute" listings that contain absolute addresses and fully linked object code.

3. LINKER: The **CrossCode C** linker is designed to handle truly huge loads. There are no limits on the number of symbols in your load or on the size of your output file. And you can always count on full 32 bit target addressability, because the linker operates comfortably in the highest ranges of the 68030's address space.

4. DOWNLOADER: CrossCode C comes with a *downloader* that puts you in touch with all EPROM programmers and emulators. It can convert your load into Motorola S-Records, Intel Hex, Tek Hex, Extended Tek Hex, and Data I/O ASCII Hex. You can also produce a binary image and convert that image into any format you might want. In all formats, bytes can be split into EPROMs for an 8, 16, or 32 bit data bus.

Why Wait

Once you start using **CrossCode C**, you may just wonder how you ever got the job done before! It's available under MS-DOS for just $1595, and it runs on all IBM PCs and compatibles (640K memory and hard disk are required). Also available under UNIX, XENIX, and VMS.

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also part of the package.

I tried a beta version of SuperScope (version 1.0b1) on a Mac II equipped with a SuperMac 19-inch monitor, 5 megabytes of RAM, and a Rodime Cobra 210e hard disk drive. It was running System 6.0.3 software. To handle data measurements, GW Instruments provided its MacAdios II/16 data acquisition board, MacAdios-fg function generator, and MacAdios ABO analog breakout box.

Due to a mailing glitch, I didn't receive a SuperScope manual. However, I found that I could do without it. By simply pointing and clicking, I was able to set up a display, save its configuration, and make measurements without the manual. In order to make a new display, you just click on an arrowhead on the scope window. To add a new data channel, you just have to press one key. And deciding what signals will appear on the display is simply a matter of dragging names about inside a dialog box. It was also easy to build a new display and plot one signal against another to get a Lissajous figure in the second window. When I wanted to change the MacAdios-fg function generator's output, I just had to select from the menu and dialog box.

If you're familiar with the way an oscilloscope operates, SuperScope should also be familiar to you, and you probably won't need to refer to SuperScope's manual, except for the finer points of operation. SuperScope goes a long way toward making the lab worker's life easier when handling the storage and display details involved with data acquisition.

The combination of GW Instruments' MacAdios data acquisition boards and its SuperScope software now makes the Macintosh a powerful tool for laboratory and research work. Now, if someone would only develop tools to make the wiring easier....

—Tom Thompson

PC-File Grows Up

What began as a simple flat-file database originally sold as shareware is now ready to take on other dBASE compatibles. **PC-File 5.0** is larger and a little easier to use than previous versions.

I've used PC-File+ to build a database of all products and companies mentioned in What's New over the last five years. It started as a simple method of fact-checking and has blossomed into a valuable resource of information contained in about 3000 records. And as any database gets larger and more complex, its uses grow, and the need for a sophisticated yet simple method of managing the information becomes crucial.

I now need to import and export files from other databases over a network, and I was afraid I'd chosen the wrong product for the job. But along came PC-File 5.0.

In order to import my old PC-File records, I learned, through a kind of klutzy processs, that I couldn't just import the original records. I first created an empty database structure with fields that matched the original, and then I went back to the original and converted the old records to dBASE format before importing them. Once I figured it out, the process went quickly. But it wasn't intuitive, nor was it explained clearly enough in the manual.

Once the records were imported, I was able to produce reports faster and more easily than with PC-File+.

This may be because the free-form report interface is easier to use than in version 5.0. Searches were also amazingly fast, as long as I searched on the indexed field. And wild-card searches are supported, which made it fast and simple to produce a lengthy report. To index, you choose the field or fields you want indexed (up to nine) when you define the database. Searching through almost 3000 records on an unindexed field was so slow that I decided I'll never do that again.

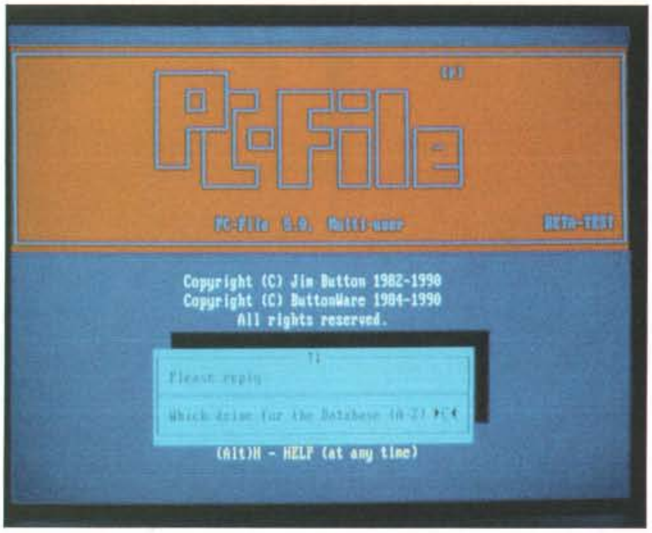
Just a few of the new features added to version 5.0 include a maximum of up to 128 fields per database (up from 70), mouse support, auto-dialing, and a new Drop to DOS feature. This last feature is handy if you have to free up as much as 500K bytes of RAM to run another application. Another addition is a Global find, which looks in all fields at once. The user interface appears much the same as in earlier versions, but it is refined somewhat and easier to use. One vast improvement is the ability to perform an add right after a find, when in the past you had to drop back to the main menu and start all over from the beginning. Also added is the ability to output graphics to PostScript-compatible devices.

PC-File also lets you produce a variety of charts and graphs, including vertical bar charts, line graphs, scatter charts, and pie charts. Graphs can be fairly complex, and they can show moving averages, or you can include grids.

The manual is well written, and it's organized with simple installation instructions, a tutorial, and fairly straightforward explanations of the database's functions. However, I would have been happier if it were clearer on how to import data from earlier versions of the program.

When it comes to function, version 5.0 is no longer in the shareware league. It has stepped out to take its place among the leaders of the flat-file database pack. And its price is about $200 less than some of its leading competitors in the market. ■

—Anne Fischer Lent



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Please reply

Which drive for the Database (A-Z) ▸C◂

(Alt)H - HELP (at any time)

THE FACTS

PC-File 5.0
$129.95

Requirements:
IBM PC or compatible with 1 megabyte available on the hard disk drive, at least 512K bytes of RAM, and DOS 2.0 or higher.

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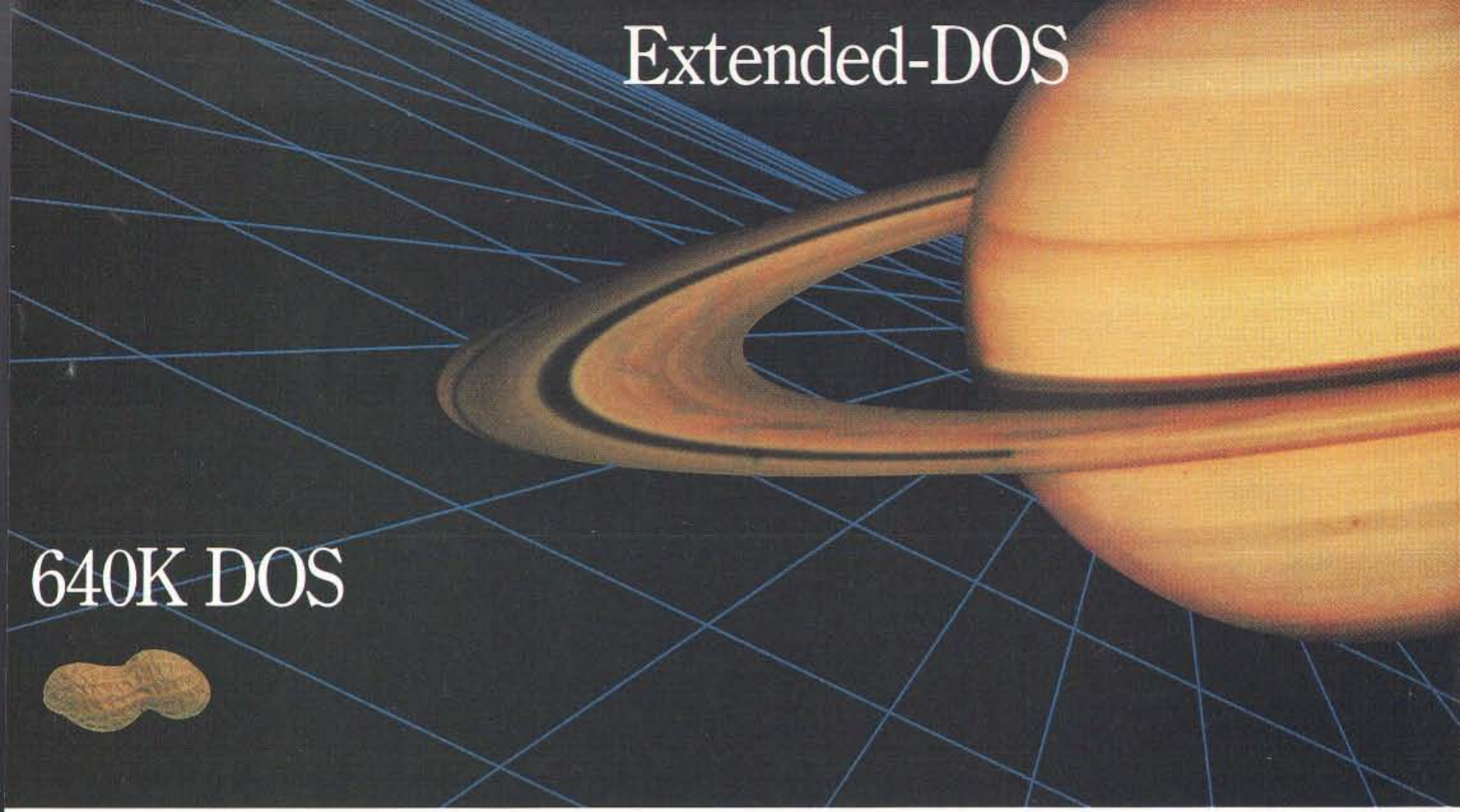
P.O. Box 96058
Bellevue, WA 98009
(206) 454-0479
Inquiry 992.



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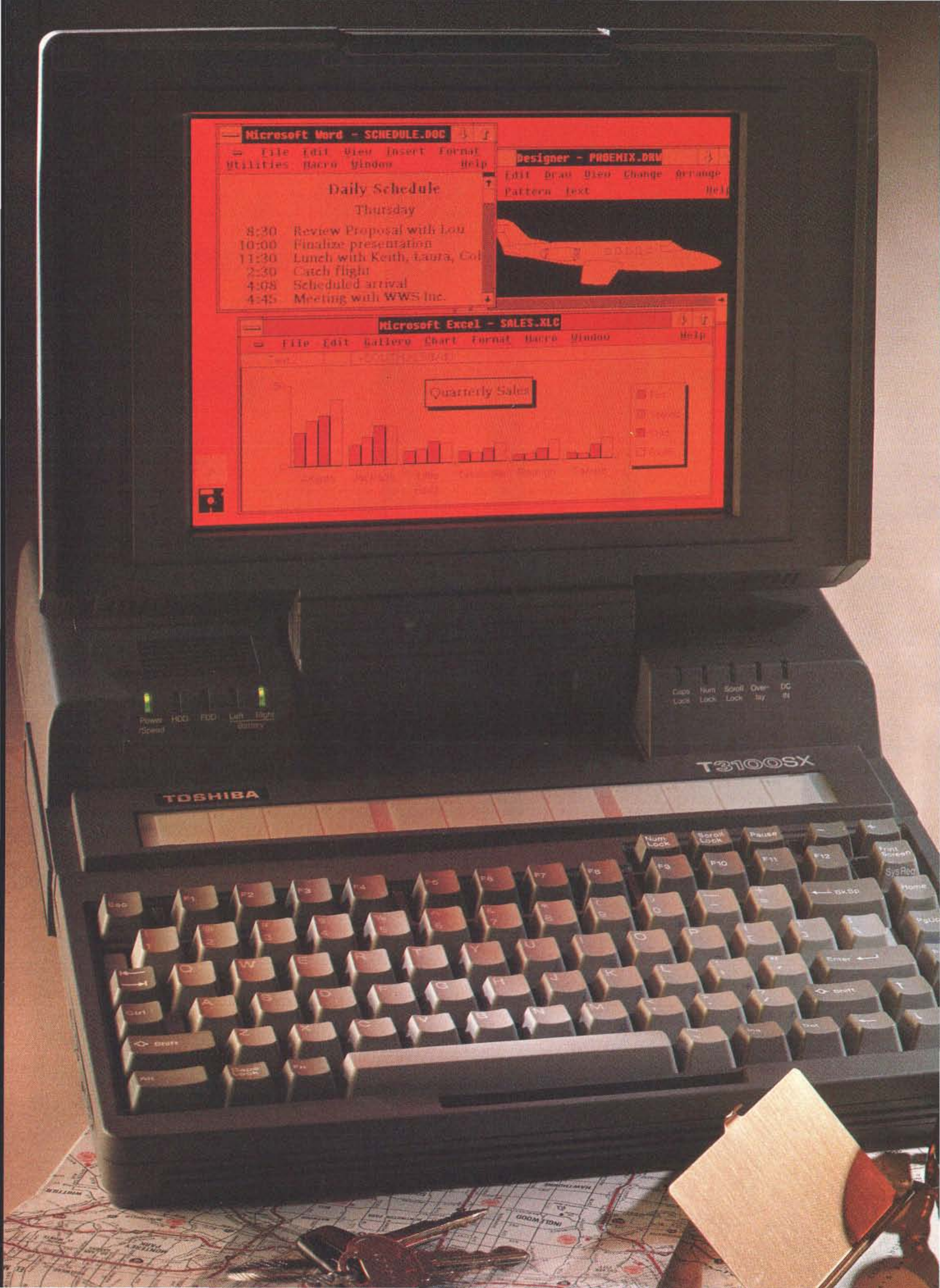
Circle 221 on Reader Service Card

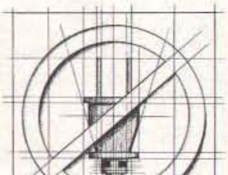

Microsoft Word - SCHEDULE.DOC
File Edit View Insert Format
Utilities Macro Window Help
Designer - PHOENIX.DRW
Edit Draw View Change Arrange
Pattern Text Help
Microsoft Excel - SALES.XLC
File Edit Gallery Chart Format Macro Window Help
Quarterly Sales
Power /Speed HDD FDD Left Right Battery
Caps Lock Num Lock Scroll Lock Over- lay DC IN
T3100SX
TOSHIBA

Daily Schedule

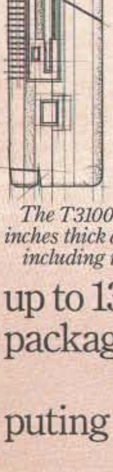
Thursday

8:30 Review Proposal with Lou
10:00 Finalize presentation
11:30 Lunch with Keith, Laura, Col
2:30 Catch flight
4:08 Scheduled arrival
4:45 Meeting with WWS Inc.

We've pulled the plug on 386SX technology.



Since the T3100SX is battery operated, you can utilize powerful 386 applications anywhere you choose.



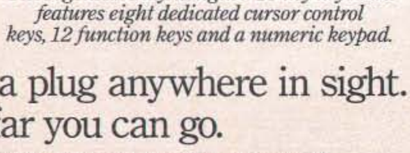
The T3100SX's slim case is only 3.15 inches thick and weighs just 14.9 pounds including its two standard batteries.

The top of a desk is no longer the only place 386-based computing gets done. That's because we've come up with a battery-powered alternative that works anywhere. It's known simply as the T3100SX.

First of all, we gave it a powerful 386SX processor. So it can handle multitasking operating environments like Windows 386 and OS/2 with ease.

Next, we devised an ingenious display system unlike anything you've ever seen on a battery-powered portable. It combines both VGA and gas plasma technology, boasts a 100:1 contrast ratio and can support both an internal display and an external monitor simultaneously.

Finally, we gave it a 40MB hard disk, a 1.44MB 3.5″ floppy disk drive and 1 megabyte of RAM, which you can expand up to 13MB. All in an easy-to-carry, 14.9-pound package that goes wherever your work is.

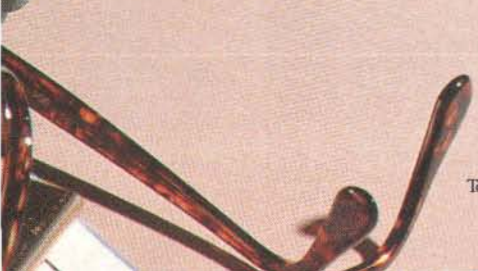


The ergonomically-designed 86-key keyboard features eight dedicated cursor control keys, 12 function keys and a numeric keypad.

So now you can put the latest 386 computing power to work for you, even if there isn't a plug anywhere in sight.

The Toshiba T3100SX. Take it. See how far you can go.

T3100SX: 14.9 pounds, 16MHz 386SX with 80387SX math coprocessor socket; 40MB hard disk with 25msec access, two removable, rechargeable batteries; three dedicated Toshiba memory slots, one dedicated Toshiba modem slot, one Toshiba general purpose slot; 1MB RAM expandable to 13MB, gas plasma VGA display with 16 gray scales and 100:1 contrast ratio; 1.44MB 3½″ diskette drive. For more information call 1-800-457-7777.



In Touch with Tomorrow

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Toshiba America Information Systems Inc., Computer Systems Division

Circle 287 on Reader Service Card

Compaq's Reason to Believe in EISA

Tom Yager

The 80386 is riding high; there's no doubt about that. We are faced with so many choices now that each new entry in the endless parade of systems only serves to confuse us more. With all the sameness out there, something had to come along to shatter the mold, to bring us to the start of a new era.

If you believe Compaq and other vendors who support the Extended Industry Standard Architecture (EISA) bus, the reign of the ISA (Industry Standard Architecture, or 16-bit "AT bus") is all but over. From what I've seen of Compaq's Systempro, ISA should be deep-sixed by people who expect their total system performance to match the capabilities of their CPU.

The Source of the Power

The Compaq Systempro is housed in a large, impressive tower case, driving home the point that Compaq does not expect this system, with its $16,000 base price, to wind up on your desk. The company is targeting this machine as a network file server and high-end Unix system.

To understand why the Systempro is particularly well-suited to these tasks, you need to dig down to its roots. The soul of this new machine is its bus, actu-

PHOTOGRAPHY: PAUL AVIS © 1990

EISA brings superb performance to the Compaq Systempro network file server and Unix powerhouse

ally *buses*. The first of these, which Compaq has dubbed Flex/MP (the MP stands for multiprocessing), makes it possible to install multiple CPUs in the Systempro and have them share a fast path to memory. The peripheral bus is the much-ballyhooed EISA. This opens the door to vastly improved performance for high-speed I/O controllers for devices such as networks and hard disk drives. As if to illustrate the capabilities of these buses, Compaq has introduced its own coprocessor board for the Systempro that lives on the Flex/MP bus. The strength of EISA is well demonstrated by Compaq's Intelligent Drive Array (IDA) hard disk drive controller.

The makeup of the CPU portion of the Systempro (with a single processor) is familiar: a 33-MHz 80386 processor with 64K bytes of cache memory, and sockets for Weitek 3167 and Intel 80387 numeric coprocessors. Beyond this, there's nothing typical about the Systempro. As mentioned above, the Flex/MP's claim to fame is its capacity to support multiple processors. Compaq presently offers a second 33-MHz 80386, with a promise to provide the i486 when it becomes available in quantity.

Shifting to Second Gear

Compaq's performance claims for multiprocessing—"from 8 to 40 million instructions per second"—are staggering, if not a bit unbelievable. The addition of the second 80386 is reported to add up to 100 percent to performance, but this optimistic figure is based on applications that can run entirely in the cache. Since access to memory is exclusive, when both processors want to access memory at the same time, one of them has to wait. This presents the most serious impact to performance. While adding a second processor won't double your performance, you can expect an increase of 80 percent or 90 percent, *depending on your application*.

I can't stress the previous sentence enough. Anyone who purchases this system with an expectation of cutting his or her Lotus 1-2-3 recalculation time in half will be disappointed. To work with multiprocessing, your software must be capable of multi*tasking*. To wit, DOS won't even notice the second processor, and unless your version of Unix or OS/2 has been doctored, they won't see it, either. Software must be specifically aware of multiprocessing as Compaq implemented it to gain anything.

The best illustration of the Systempro's multiprocessing prowess comes from The Santa Cruz Operation, which enhanced its Unix product with software from Corollary, Inc. These patches to Unix set things up so that when a task is scheduled for processor time (which is done several times a second), it can run on either of the two processors. Further, the Unix kernel has been modified; reentrant portions are marked as safe to run on the second processor.

Still, the implementation is not perfect. Only the primary processor can handle I/O, so that any program that does a lot of it, like a network driver, is limited to running as it would in a single-processor system. The other flaw lies in Compaq's weak support of a multiprocessing OS/2. A version of LAN Manager has been built to run on the second processor, but only that program, and the handler for the High Performance File System, can run there; the rest of OS/2, along with applications, must run on the primary processor. Further, since all I/O is handled by the primary processor, only the housekeeping portions of LAN Manager (e.g., busting up incoming network packets) can be handled by the coprocessor. As a result, the increase in performance is minimal, since the load on the second processor would likely never rise high enough to take any real load off the primary one. OS/2's threads and multitasking make it an ideal target for full multiprocessing support, and perhaps we'll see that in the future.

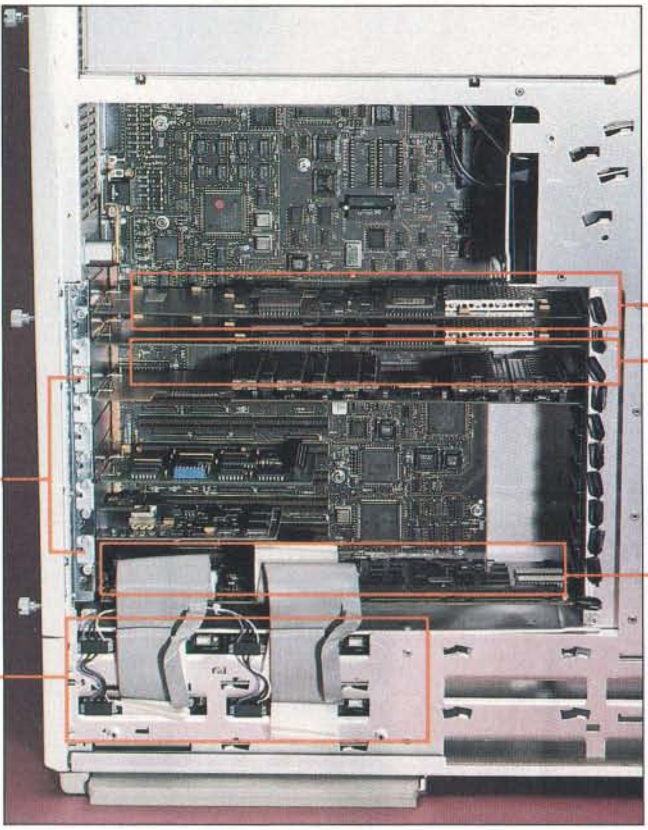
Brains with Your Drive, Sir?

Compaq's other innovation is, again, an accessory that illustrates the strength of the Systempro's design. The new IDA controller (standard with the Systempro) brings uncommon speed and storage capacity to this machine. Equipped with an on-board 80186 CPU, this card can service up to eight hard disk drives (actually, four drive pairs). Each drive has a separate control cable, and each pair shares a data cable. Drives can be searched simultaneously with this scheme, and multiple drives not on the same data cable can be read or written to at the same time. Further, the controller makes all attached drives appear as one huge drive. In its present maximum configuration, the controller can handle up to 4.28 gigabytes of storage.

Sector striping, a concept familiar to minicomputer and mainframe users, provides the final boost for the IDA. As noted, the entire cluster of drives appears as one large drive, but the layout is not what you might expect: Instead of organizing the storage sequentially (i.e., the first 210 megabytes on drive 1, the second 210 megabytes on drive 2, and so on), striping places data on the disks such that sector 1 is on drive 1, sector 2 is on drive 2, and so on. Reading data from a large (but still less than the size of one drive), contiguous file, from beginning to end, would involve all the drives. Since the IDA is capable of reading from multiple drives simultaneously, data flies off the disks.

The controller uses bus mastering to transfer data directly from the disks to system memory, so I/O can be done asynchronously. The driver can move on to handle the next I/O request without waiting for the previous one to finish. Compaq has developed drivers for DOS, OS/2, Unix, and Novell's NetWare 386, and you can expect others. Another benefit of asynchronous I/O is that, as additional tasks (i.e., users or processes) are

continued


Two 33-MHz 80386 processor boards with sockets for 33-MHz Intel 80387 or Weitek 3167 math coprocessors
12-megabyte memory, shared by both processors
32-bit EISA slots
Intelligent Drive Array hard disk drive controller
Four 3½-inch 210-megabyte hard disk drives (room for four more)

Highlights of the Compaq Systempro as evaluated.

added, the performance curve stays relatively flat. The IDA excels at juggling mountains of requests, so five users doing heavy disk I/O can expect nearly the same performance.

Striping creates one problem that is at least as large as the one it solves: What happens if a drive dies? That would leave holes throughout the file system, so a single drive failure would be immediately fatal—nothing would run. To answer this, Compaq built two levels of fault tolerance into its IDA: mirroring and data guarding. NetWare/SFT users know all about mirroring, which is the practice of having twice as many drives as you need; half of them simply maintain mirror images of the others. When a drive fails, the mirrors kick in and no data is lost. Not everyone is willing to accept the high cost overhead in maintaining large disk farms, so Compaq's alternative, data guarding, is attractive.

Requiring half the overhead (25 percent instead of 50 percent) of mirroring, data guarding involves setting aside one-quarter of your disk space for a combined drive image. Each time a byte is written to a drive, the byte at the same position on all other drives is read. The results are then XORed together and placed in the data guard area. When a drive fails, its data can be recovered by reversing the process: Read 1 byte from all but the failed drive, XOR them together, and you get the missing data. The IDA can be instructed to restore data to a newly replaced drive in the background, reducing downtime to the time it takes to remove and replace the damaged drive. The drive array can be used while it is being restored.

A Perfect Fit

The Systempro has seven EISA slots and four Flex/MP slots. Six of the EISA slots are left open in the standard configuration, and two of the Flex/MP slots are left open. An Integrated Video Graphics System provides up to VGA-quality resolutions; aided by an accelerator, this card is up to 50 percent faster than a typical VGA, according to Compaq. The Systempro has 11 hard disk drive slots, and the floppy disk and tape drives are angled upward slightly for easier insertion. Several third-party vendors are offering 32-bit network adapters, making it possible to push Ethernet and Token Ring networks to near their potential.

All things considered, the Systempro seems nearly a perfect fit for the market Compaq is aiming for: high-speed, high-traffic network file-serving and demanding multiuser applications. The IDA is the star of the show, with obvious advantages over even souped-up ISA controllers. The real benefits of multiprocessing will become apparent later, but Compaq has shown real courage in building the capability into its first EISA machine. For all its new technology, and for showing so plainly the strengths of the EISA bus, the Systempro deserves an award for innovation. Users of large or performance-intensive networks will agree. The Systempro is a winner. ■

Tom Yager is a BYTE technical editor. You can reach him on BIX as "tyager."

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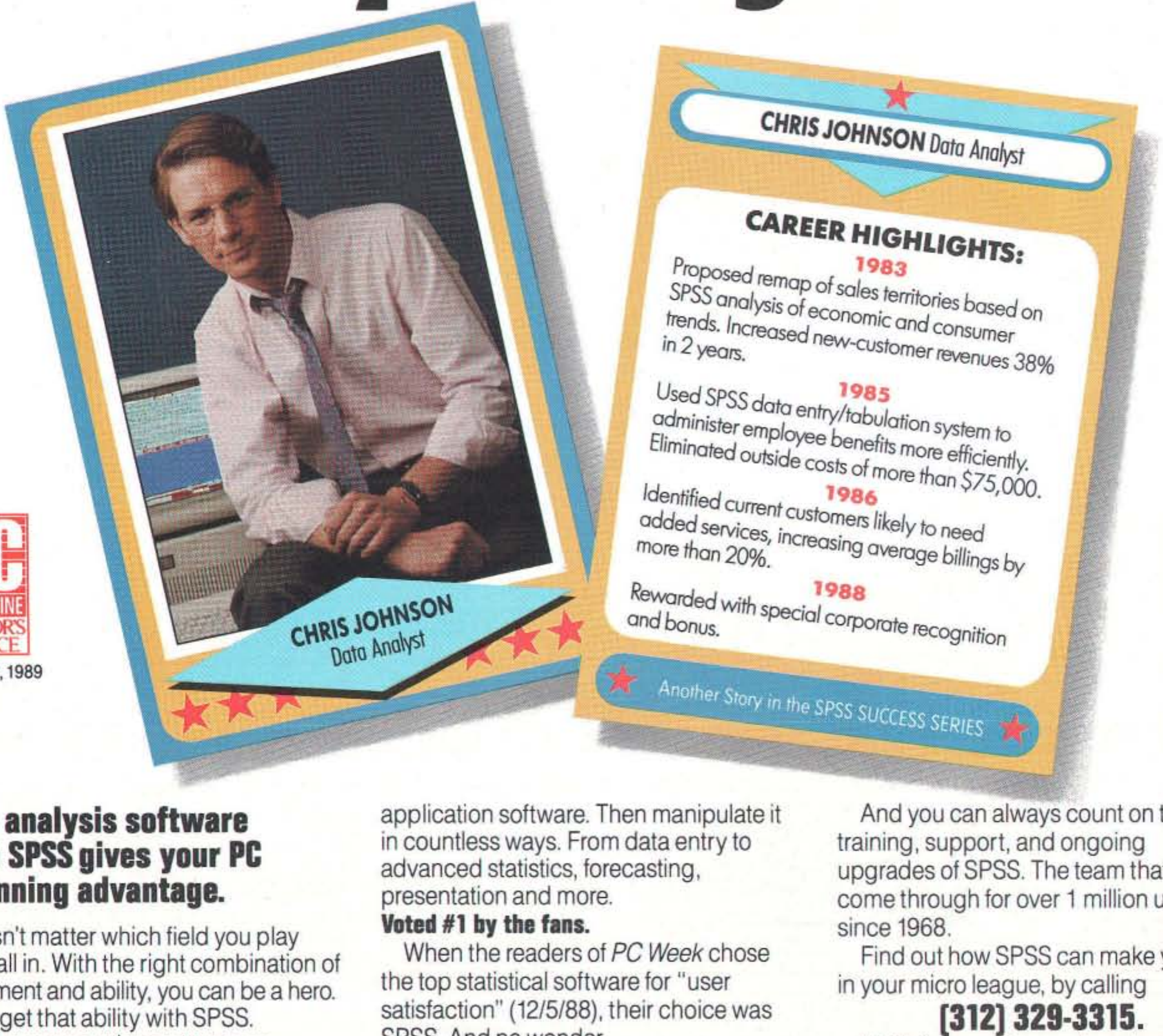

CHRIS JOHNSON Data Analyst

CAREER HIGHLIGHTS:

1983
Proposed remap of sales territories based on SPSS analysis of economic and consumer trends. Increased new-customer revenues 38% in 2 years.

1985
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1986
Identified current customers likely to need added services, increasing average billings by more than 20%.

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Rewarded with special corporate recognition and bonus.

Another Story in the SPSS SUCCESS SERIES

PC MAGAZINE EDITOR'S CHOICE
March 14, 1989

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Circle 267 on Reader Service Card

A VGA on Every Desk

As prices fall and color applications take over, VGA now belongs on almost any PC

Stanford Diehl
and Howard Eglowstein

In these heady days of dazzling color applications and graphical user interfaces, VGA seems irresistible. At the very least, it deserves software's highest rating: not required, but *strongly* recommended. With street prices falling within the realm of the strictest budgets, the question is no longer "Why do you need graphics?" but "Why not?" Aesthetic considerations aside, graphics has now become an issue of productivity.

Only a few short years ago, the first color graphics standard, CGA, was released for the IBM PC. CGA could support a maximum resolution of 640 by 200 pixels in monochrome or 320 by 200 pixels with four colors. We've come a long way since then. Every major display manufacturer now uses VGA as its standard color display adapter. Most of these boards are functionally the same, but the monitors can vary widely in quality and price.

The VGA monitor that you choose for your machine will depend on your applications, your budget, and your future expansion plans. It stands to reason that the more you spend on a monitor, the better the image you'll get. A good display for a graphics application should have bright, vivid colors, while the ideal word processing display should have clear, easy-to-read characters. Another factor to consider is your plans for the future. Are you planning to use this monitor with the emerging, higher-resolution display boards? Monitors with multiple video synchronization rates can handle well beyond VGA's maximum of 640 by 480 (columns by rows) pixels. Inexpensive monitors may work well with the VGA card you buy today but might not handle the new card that you buy next year.

The BYTE Lab staff evaluated 26 color monitors, all priced between $399 and $750 and sold specifically for VGA-compatible display cards. (Budget-minded buyers, take note: VGA-compatible monochrome displays cost substantially less than their color cousins, and by substituting gray levels for color, they let you run all your favorite VGA software.)

Color Basics

A video monitor uses a beam of electrons to "paint" the image onto a vast array of red, green, and blue phosphor dots. Starting from the upper left, the beam scans across to the right, turning the dots on and off as required. When the beam reaches the edge, it zips back to the left, goes down one line, and repeats the process over and over, until the entire screen has been zapped. This process takes place 60 or 70 times per second on a VGA monitor. It's the VGA display card's responsibility to direct the beam, but the overall display quality depends largely on the precision of the display electronics and the size of the phosphor dots.

At the maximum VGA resolution, the beam aims for 640 discrete points across the screen. If a monitor has fewer than 640 groups of RGB dots, a pixel will span more than one physical group, giving a grainy appearance. Generally, the closer together the phosphor dots are, the better the display. Distance between the RGB dots is the *dot pitch*, usually given in millimeters.

Misconvergence is typically the reason why some monitors have difficulty displaying white text. To display white, the electron beam has to hit the red, green, and blue phosphor dots that correspond to a pixel. Ideally, the beam will hit all three dots in a group without hitting any in adjacent groups. When the beam hits the three intended RGB dots, the group looks white. A common problem is that the beam will also touch on one color of the RGB dot group next door. The resulting image will have a slight shadowed appearance, as if there's a colored halo to one side. The convergence of a monitor will probably change as the monitor gets older.

Unless there's a serious problem with the display tube, misconvergence can often be corrected by a qualified technician. You should not try it yourself—there are some pretty scary voltages in a color monitor. Some monitors have a "text" mode that displays the text with one or two phosphor colors, minimizing the effects of misconvergence.

VGA cards generate video at frequencies of up to 34 MHz. The more dots the card has to address, the higher this frequency will be. A 34-MHz *bandwidth* is sufficient for the VGA's maximum (640-by 480-pixel) resolution. However, all VGA-compatible monitors can change their scan rates as needed. CGA display modes require about half the bandwidth of a VGA screen. While all the monitors we tested can handle the lower scan rates, none of them are intended to scan any faster. Should you later decide to buy a fancier display card, you might have to buy a new monitor. As an alternative, consider spending a bit more for one of the many *multiscanning* monitors. These will adapt to faster display cards, possibly saving you hundreds of dollars in the long run. For most of us, though, any of the monitors in this test are a good balance between price and features.

Fingertip Control

Most people, when buying their first color monitor, will use a TV set as their

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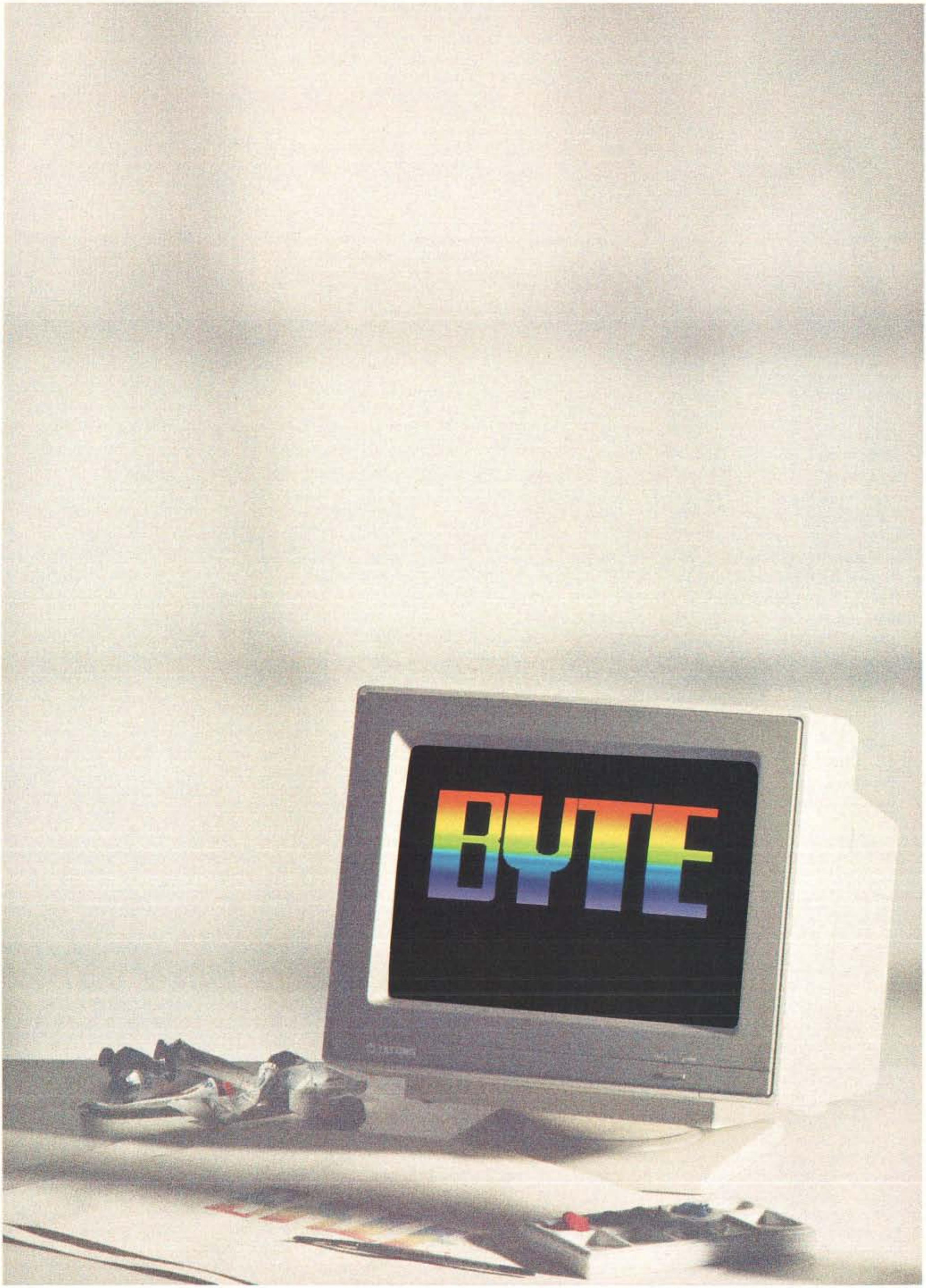

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LOW-COST VGA MONITORS

When selecting a VGA monitor, you should consider several features, the most revealing of which is the dot pitch specification. Most VGA monitors support 640- by 480-pixel graphics resolution and use 720 by 400 pixels for text. The Princeton PSC-28 goes a step further, delivering 770- by 570-pixel resolution for Super VGA boards. (●=yes, ○=no.)

Model	Price	Size (inches)	Diagonal size (inches)	Maximum resolution	Dot pitch (mm)	Bandwidth (MHz)	V. scan freq.[1]	Weight (lbs.)
Acer 7013A	$510	14.2 × 14.6 × 13.6	14	640 × 480	0.31	30	50-70 Hz	28.6
Amstrad PC14 CD	$399	14.6 × 13 × 14.8	14	640 × 480	0.42	28	60-70 Hz	26.9
Amstrad PC14 HRCD	$639	14.6 × 13 × 14.8	14	640 × 480	0.29	28	60-70 Hz	26.9
AST ASTCVGA	$695	14.1 × 12.2 × 14.2	14	640 × 480	0.31	30	60-70 Hz	31
CTX CVG-5432	$579	14.8 × 14.4 × 14.2	14	640 × 480	0.29	30	60-70 Hz	26.4
Epson A804031	$599	14.4 × 15.5 × 12.8	14	640 × 480	0.31	28.5	60-70 Hz	26.5
IBM 8512	$623	14.6 × 15.5 × 14	14	640 × 480	0.41	31.5	60-70 Hz	35
IBM 8513	$750	12.3 × 14.5 × 12.6	12	640 × 480	0.28	31.5	60-70 Hz	23
Imtec 1430V	$399	14 × 13.8 × 15.2	14	640 × 480	0.31	30	60-70 Hz	25.3
Laser 6448	$499	14 × 13.2 × 16.3	14	640 × 480	0.31	30	50-70 Hz	33
Magnavox CM9032	$499	12.8 × 14 × 16	14	640 × 480	0.42	18	60-70 Hz	25.7
Magnavox Pro 9CM082	$649	12.8 × 14 × 16	14	640 × 480	0.31	18	60-70 Hz	25.7
Mitsuba 710V	$495	13.7 × 14.1 × 14.6	14	640 × 480	0.31	20	60-70 Hz	37
Mitsubishi XC1429CH	$658	12.3 × 13.9 × 15.4	14	640 × 480	0.28	30	60-70 Hz	26
Packard Bell PB8531VG	$699	12.75 × 14 × 15.75	14	640 × 480	0.31	28	50-70 Hz	25.3
Packard Bell PB8552VG	$469	12.75 × 14 × 15.75	14	640 × 480	0.52	28	60-70 Hz	25.3
Princeton PSC-28	$695	2.6 × 12.3 × 14.3	13	770 × 570	0.28	30	50-70 HZ	27
Quimax DM-3114	$699	13 × 12.7 × 13.4	14	640 × 480	0.31	30	50-70 Hz	30
Relisys RE9513	$699	14.3 × 14.2 × 14.8	14	640 × 480	0.31	35	50-70 Hz	31
Samsung CJ4681	$699	14.5 × 14.1 × 15.1	14	640 × 480	0.31	30	60-70 Hz	26.46
Tandy VGM 200	$499	12.2 × 14.5 × 14	14	640 × 480	0.42	28	60-70 Hz	29.2
Tandy VGM 300	$629	12.2 × 14.5 × 15	14	640 × 480	0.31	28	60-70Hz	29.2
Tatung CM-1296	$625	12.7 × 11.2 × 12.4	12	640 × 480	0.28	30	50-70 Hz	23.1
Tatung CM-1496	$685	14.3 × 12.4 × 15.8	14	640 × 480	0.31	30	50-70 Hz	27.5
Wyse WY650	$669	12.6 × 12.6 × 14.5	12	640 × 480	0.28	25	50-70 Hz	23.3
Zenith ZCM-1390	$699	12.98 × 14.2 × 14.97	13	640 × 480	0.31	25	60-70 Hz	29

[1] Horizontal scan frequency on all monitors is the VGA standard of 31.5-kHz.

[2] This monitor has separate sync controls for each of the VGA display modes.

reference. On a VGA display monitor, expect to find both brightness and contrast controls. These have the same function as the equivalents on your TV. Missing will be the hue (tint) and saturation (color) controls—since the video is sent to the monitor as separate RGB signals, these controls, which alter the way in which a TV interprets color, are not necessary.

Most of the 26 reviewed monitors have what's known as "VSYNC" controls that allow you to tweak the vertical sync to match your VGA card. One feature that we were surprised to find on some models was multiple VSYNC controls. Because a VGA display has to synchronize differently at CGA, EGA, and VGA video rates, it makes sense that each of the three vertical sync rates can be adjusted separately. It's not a really useful feature, but it could come in handy in adjusting your monitor for some VGA cards. The Imtec 1430V, Packard Bell PB8531VG and PB8552VG, Samsung CJ4681, and Tandy VGM 200 and VGM 300 all include multiple VSYNC controls.

Horizontal and vertical size controls let you adjust the width and height of your display. These adjustments give you greater control over the displayed image. Of the two, the vertical size control is the more useful. The Acer 7013A, CTX CVG-5432, Epson A804031, Mitsubishi XC1429CH, and Relisys RE9513 offer only vertical size control. Keep in mind, though, that width and height must also remain in a proper relationship, or *aspect ratio*. Otherwise, your image will appear distorted, and a circle may appear to be an oval. You may have trouble maintaining aspect ratio if you adjust the height of your image without also adjusting its width. The Magnavox and Zenith monitors deliver both vertical and horizontal sizing controls.

The positioning controls, on the other hand, move the entire display image around on the screen. In this way, you can center the image properly. The AST ASTCVGA, CTX CVG-5432, Magnavox CM9032 and Pro 9CM082, Mitsuba 710V, and Zenith ZCM-1390 provide both horizontal and vertical positioning controls. The full complement of adjustment knobs for the Magnavox monitors are tucked away under a folding cover at the front of the unit. Zenith placed all the knobs (except those for brightness and contrast) at the rear of the unit, and you need a screwdriver to get at them. If you demand precise alignment of the display image and easy access to the control knobs, only the Magnavox models can deliver.

Base/screen			Controls in addition to brightness and contrast						
Tilt/ swivel	Nonglare	Polished	H. position	V. position	H. size	V. size	V. sync	Text mode	Warranty (years)
●	●	○	●	○	○	●	○	○	1
●	○	●	○	○	○	○	●	○	1
●	●	○	○	○	○	○	●	○	1
●	●	○	●	●	○	○	○	○	1
●	●	○	●	●	○	●	○	○	2
●	●	○	○	○	○	●	○	○	1
○	●	○	○	○	○	○	○	○	1
●	●	○	○	○	○	○	○	○	1
●	●	○	○	○	○	○	2	○	1
●	●	○	○	○	○	○	○	○	1
○	○	●	●	●	●	●	○	○	1
●	●	○	●	●	●	●	○	○	2
●	○	●	●	●	○	○	○	○	1
○	●	○	○	●	○	●	●	○	1
●	●	○	○	○	○	○	2	○	1
●	●	○	○	○	○	○	2	○	1
●	●	○	○	○	○	○	○	●	1
●	●	○	○	○	○	○	○	○	2
●	●	○	●	○	○	●	○	○	2
●	●	○	○	○	○	○	2	○	1
○	●	○	○	○	○	○	2	○	1
○	●	○	○	○	○	○	2	○	1
●	●	○	●	○	○	○	○	●	1
●	●	○	●	○	○	○	○	●	1
●	●	○	○	○	○	○	○	●	1
○	●	○	●	●	●	●	○	○	1

It's good to see that vendors have finally discovered what a pain it is to reach around to the back of a monitor to get to its controls. The important controls on all these models are conveniently placed on the side or on the front of the monitor. Along similar ergonomic lines, two of the units (the Mitsuba 710V and Quimax DM-3114) use slider controls instead of round knobs. The slider controls are much harder to set precisely. If you intend to set your brightness and contrast controls once and leave them alone, it shouldn't be a big deal, but if you require the kind of precise control that we did, slave-driven by the slightest deflection of a light meter, slider controls can get downright infuriating.

The VGA Connection

All the test monitors had standard VGA cabling with 15-pin analog connectors. Cable length varies, but most units had cables about 3 feet long. This should be fine for desktop installations, but people with tower CPUs might need a cable extension. We ran into that problem during the test and wound up making our own extension out of a 6-foot length of shielded cable.

On the aesthetic side, consider the monitor mount and antiglare coating. A good, adjustable base might be just the ticket to raise the monitor up and help you avoid neck strain. The best of the adjustable bases let you rotate the display from side to side and tilt it up and down. Others provide only a tilt function. Most of the monitors we tested came with a tilt/swivel base (see the table). For the other monitors, you can buy stands from most computer retailers.

If you think glare might be a problem, look for a nonglare coating on the surface of the display tube. The manufacturer etches a textured surface onto the glass or coats the glass with a special material. Monitors that have it are easier to read in bad lighting but might have a slightly fuzzy appearance. Most of the monitors in this review come with a nonglare coating. Should you opt for a monitor without some nonglare treatment, you can buy nonglare filters to retrofit most monitors.

Two last issues to consider: availability and warranty. Where can you buy the monitor? There's always mail-order companies, which often have the best prices, but then you run the usual risks of mail-order purchases. Certain monitors are available only from dealers. If you decide to buy a Tandy or IBM monitor, you'll have to walk into a dealer. And while you may pay a higher price, it's far easier to get service on the equipment that you buy from dealers.

A Fine Line Between Good and Bad

We submitted each of the monitors to the unerring eye of the Microvision Superspot testing system, a computer-controlled device that measures the light intensity coming from a small area of the monitor surface. The Superspot software displays red, green, and blue lines in turn and measures the width, intensity, and alignment of each.

The Superspot uses a sensor made up of 2048 CCD (charge-coupled-device) elements set in a single line. The software samples each of the elements and integrates the average light reading from each element over a short period of time. The small size of the elements (0.0005 inch) makes it possible to get a very accurate measure of a screen dot's shape and size. Width calculations are based on light intensity in a given area. Variance measurements (jitter, swim, and drift) are based on a dot's motion over longer periods.

For the best results, we adjusted each of the monitors to the same overall brightness. The setting that we were most concerned with was the "black level," which is the light intensity of the unlit black areas of the screen. On most monitors, this level will range from completely black to a fairly light shade of gray. We set our standard monitor, an IBM 8513, so that the black level was just barely visible in a darkened room. On subsequent monitors, a light meter ensured that each monitor displayed the same black level.

We got back a dizzying amount of information. The line width is calculated by measuring the intensity on both

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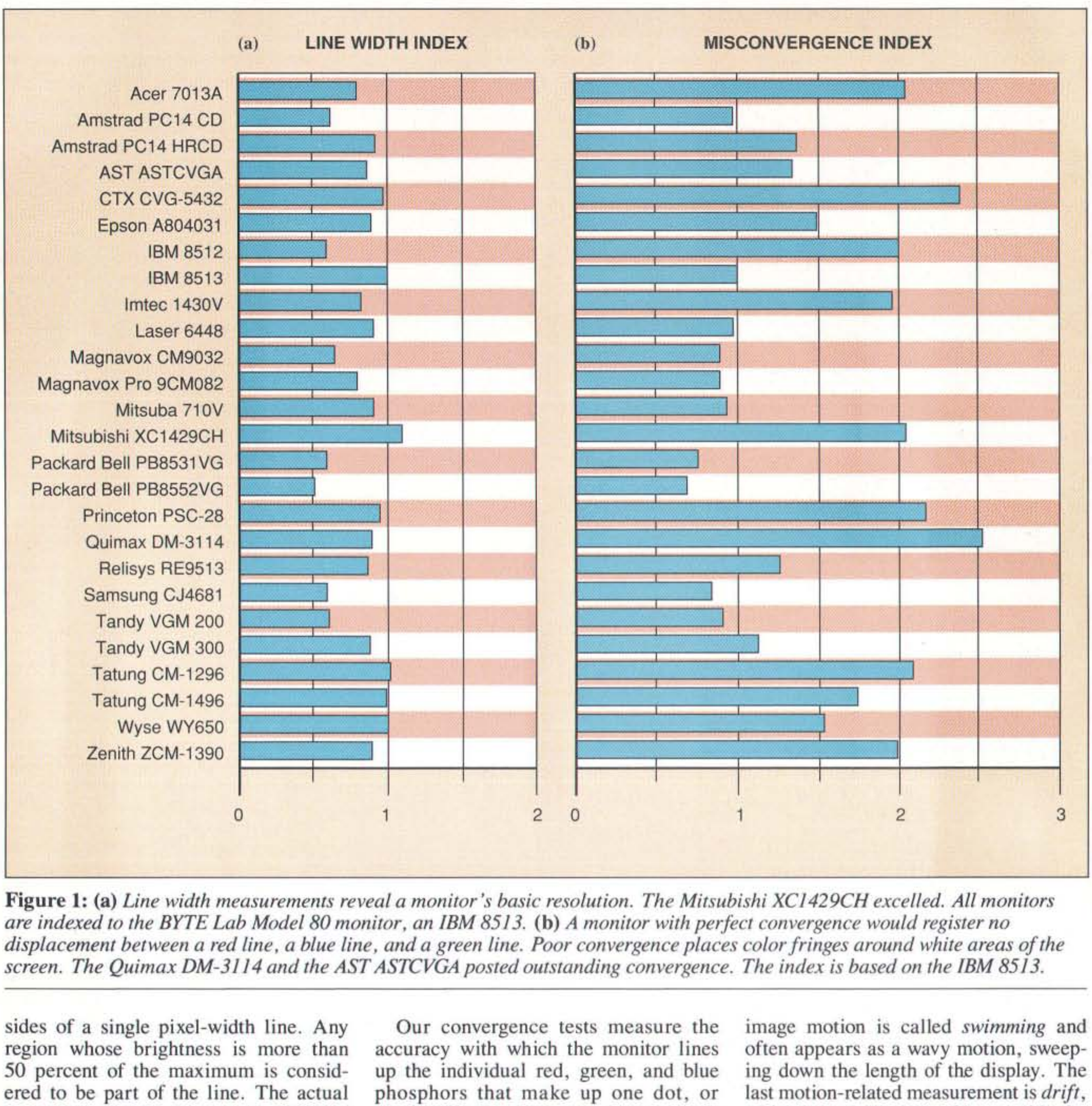

Figure 1: (a) *Line width measurements reveal a monitor's basic resolution. The Mitsubishi XC1429CH excelled. All monitors are indexed to the BYTE Lab Model 80 monitor, an IBM 8513.* **(b)** *A monitor with perfect convergence would register no displacement between a red line, a blue line, and a green line. Poor convergence places color fringes around white areas of the screen. The Quimax DM-3114 and the AST ASTCVGA posted outstanding convergence. The index is based on the IBM 8513.*

sides of a single pixel-width line. Any region whose brightness is more than 50 percent of the maximum is considered to be part of the line. The actual line width should be exactly 1/640 of the viewable display width. Theoretically, this measurement reveals the performance of a monitor at its most basic level. A broad line width would indicate poor resolution, showing up as the grainy appearance mentioned earlier. In general, the smaller the line width, the better. However, we indexed our results against the BYTE Lab's IBM 8513 monitor to provide a consistent frame of reference. So, when you study figures 1, 2, and 3, remember that, in all cases, a longer bar indicates superior performance.

Our convergence tests measure the accuracy with which the monitor lines up the individual red, green, and blue phosphors that make up one dot, or pixel. The Superspot displays separate red, green, and blue lines and expects them to be as close as possible. A big misconvergence measurement suggests that certain images could be subject to a fair amount of ghosting or colored halos.

An image that appears steady on the screen is really being updated 60 or 70 times per second. The variance measurement indicates how accurately the monitor can display an image in the same place with each successive update. Small, rapid movements of the image are termed *jitter*. Larger, slower image motion is called *swimming* and often appears as a wavy motion, sweeping down the length of the display. The last motion-related measurement is *drift*, which is an indication of how stable the picture is over time. A poor variance index suggests that the image is likely to move subtly across the screen, often imperceptibly. As the monitor warms up, the image may shift slightly to one side. These effects can contribute to discomforts such as eyestrain and headaches, among others.

In a well-designed monitor, the line width will remain fairly constant as the intensity increases. If the line width expands, the image will *bloom*, resulting in poor resolution at higher intensities. We

continued

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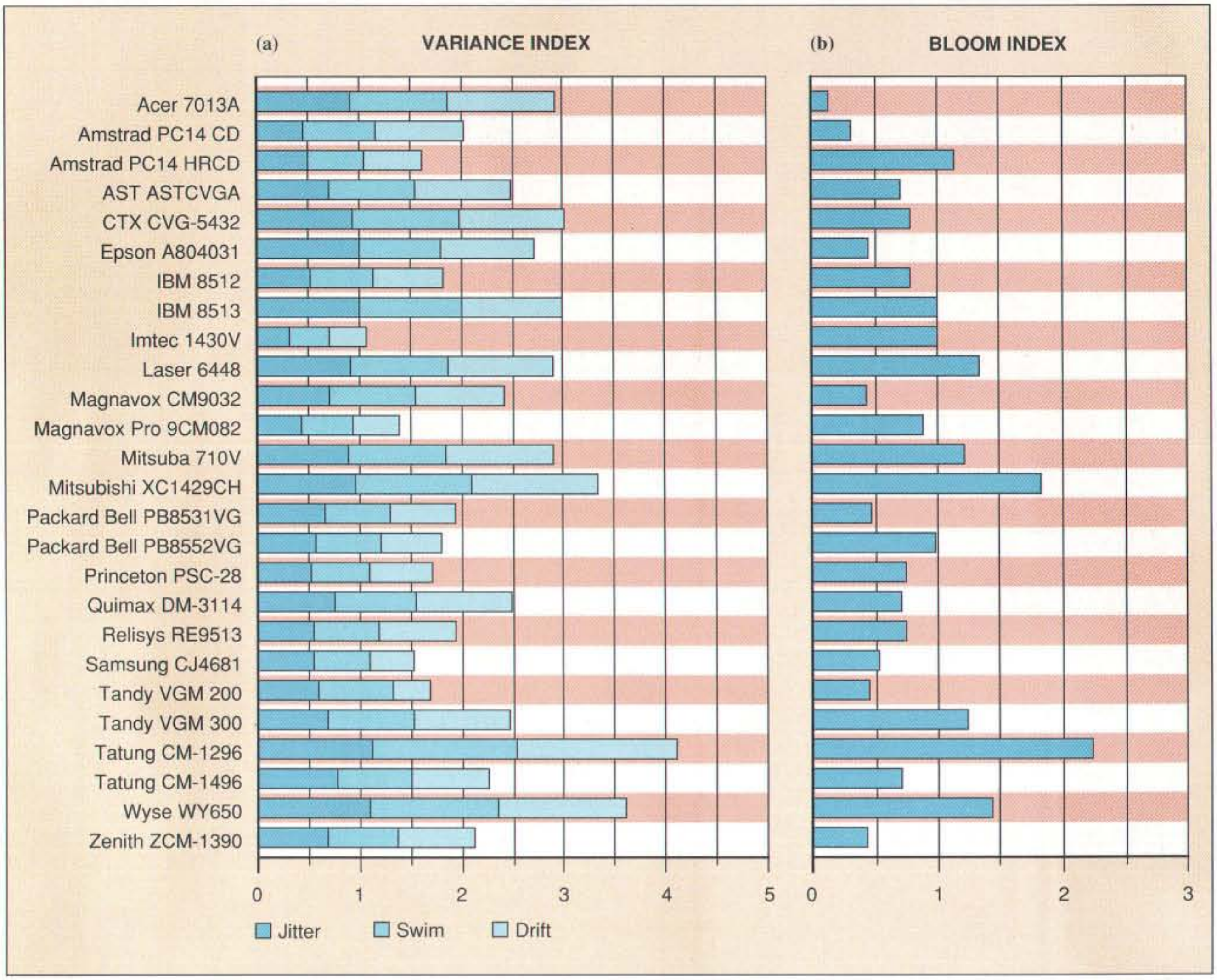

Figure 2: (a) *The variance test measures line movement at intervals of one-half second (jitter), 10 seconds (swim), and 60 seconds (drift). Monitors with a poor variance index can contribute to eyestrain and headaches. The Tatung CM-1296 displayed the most stable image, while the Imtec 1430V was stricken by the jitter bug.* **(b)** *The bloom test determines how much a spot size swells as brightness increases. As intensity increases on a monitor with a low bloom index, the pixels start to merge, effectively lowering resolution. The Tatung CM-1296 was a rose among the thorns.*

took measurements at a predefined low intensity and high intensity and then noted the change in the line width. Although you should not subject your monitor to excessive intensity, blooming might also indicate design flaws.

Under the Spotlight

Perhaps the biggest problem with our Superspot system is the sheer volume of data that it pumps out. We have worked hard to boil down this data into some meaningful information. The graph indexes represent an accumulation of test results. The line width index (see figure 1a) is an average score for 16 tests.

We started by measuring the center of the screen at low intensity. To get an accurate line width, we measured the horizontal and vertical widths of a single scan line and took the vector sum of those results. We then used our light meter to set the monitor to a standard high intensity and again took horizontal and vertical measurements. We repeated the entire process with the Superspot system concentrating on the upper left corner of the screen. This gave us a glimpse of line width at the best (center) and worst (corner) areas of the screen.

We also intended to make some design judgments by gauging the amount of line-width change from center to corner. With larger monitors, this change can offer some valuable insight. In the case of these monitors, however, we found the changes not significant enough to be of clear value. Instead, we simply averaged the results of the different tests and indexed the resulting figure against the IBM 8513.

The Superspot takes such a fine snapshot of a displayed line that it sometimes interprets a coarse line as two distinct elements. This reveals a very poor spot size. Normally, the Superspot returned a raw line width result in millimeters and also performed a "curve fit" to offer a more consistent sampling of the data. If the system picked up two discrete lines, however, the curve fit was aborted. The Acer 7013A, Amstrad PC14 CD, IBM 8512, Magnavox CM9032, both Packard

continued

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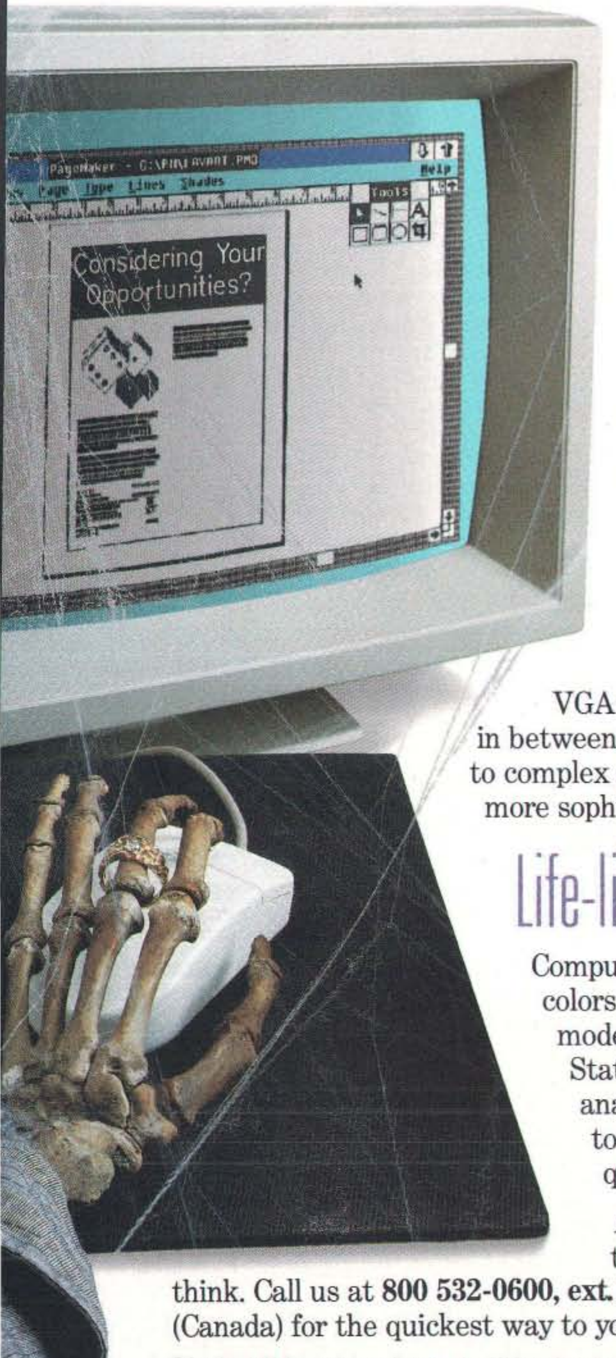

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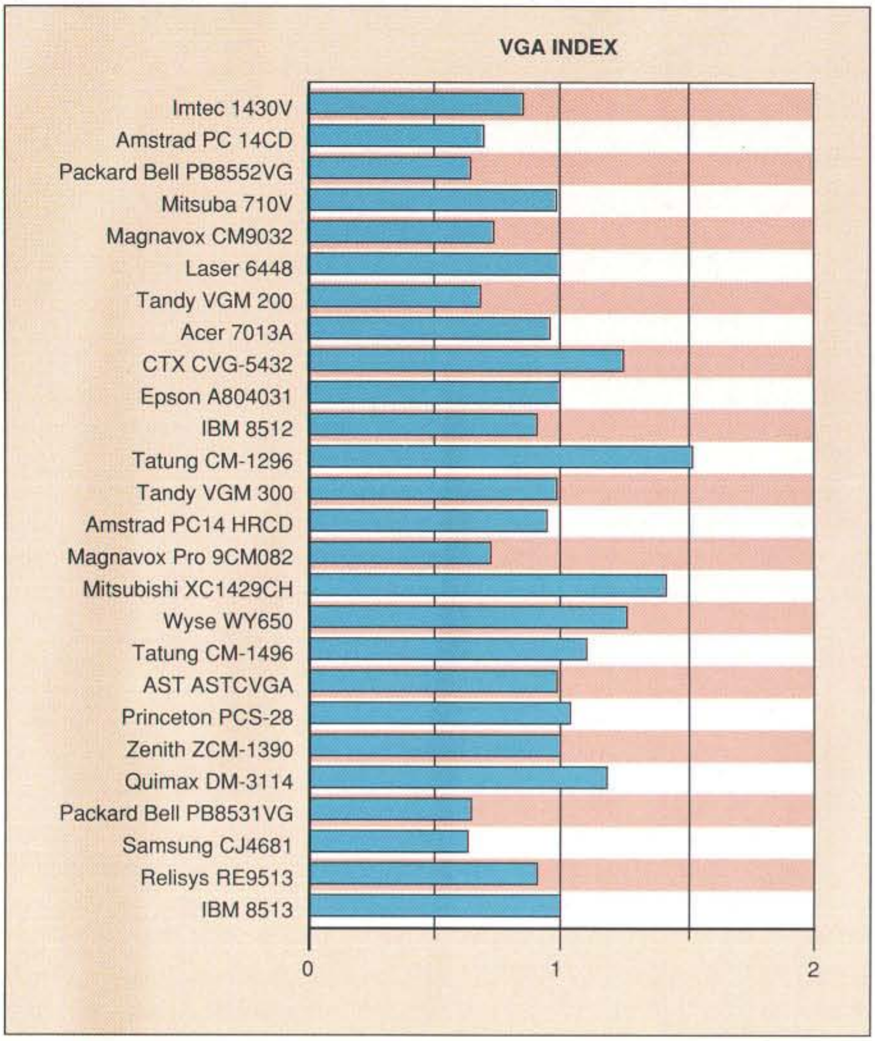

Figure 3: *The VGA index is a weighted geometric mean of the other indexes, emphasizing line width and misconvergence. Monitors are listed according to price, with inexpensive models at the top. Long bars reveal outstanding performers, so look for long bars at the top of the graph. For example, while the Laser 6448 and the Zenith ZCM-1390 have similar indexes, the Laser delivers a higher price/performance mix.*

Bell models, and the Tandy VGM 200 all displayed two lines when subjected to the discerning eye of our equipment. As you can see in figure 1a, each of these monitors returned a poor line width index. Even under close scrutiny by the naked eye, a single line appears as a pair of braided lines. In this case, poor resolution is obvious.

The Mitsubishi XC1429CH turned in the optimum line width measurement, while the CTX CVG-5432, both of the Tatung models, the Wyse WY650, and the IBM 8513 were close behind. As expected, line width results were closely tied to dot pitch specifications.

Our misconvergence index graph also represents a battery of tests, 12 in this case. In a single pass, the Superspot registers the displacement between a red and a green line, a green and a blue line, and a blue and a red line. We then took horizontal and vertical measurements at the center and at the corner of the screen. The results can be either a negative or positive number, but the only significant information is how close to zero the numbers are. Therefore, we took the absolute value of the numbers and derived an average misconvergence. Once again, the IBM 8513 provides the base figure for the misconvergence index (see figure 1b).

The CTX CVG-5432, Princeton PSC-28, and Quimax DM-3114 boasted precise convergence on our tests. To verify our assumptions, we examined some text applications on the monitors with high misconvergence indexes and saw the fine quality of white. If your applications call for heavy use of text, one of these monitors would be a good choice.

The Superspot's variance test runs for 2½ minutes, charting line movement at three intervals: a half-second (jitter), 10 seconds (swim), and 60 seconds (drift). Again, we took horizontal and vertical measurements at the center and the corner of the screen. An average result for each type of variance, indexed to the IBM 8513, is displayed in figure 2a. Each segment of a bar represents one type of variance, while the full bar presents the cumulative result. Generally, the monitors with low levels of jitter also displayed small amounts of swim and drift, and the monitors with poor variance returned unacceptable results across the board.

The Tatung CM-1296, Wyse WY-650, and Mitsubishi XC1429CH portrayed excellent stability. The results of our variance test dampened our enthusiasm, though, for an inexpensive monitor that otherwise posted surprising scores—the Imtec 1430V. Unfortunately, the 1430V suffered from excessive variance.

We derived our bloom index (see figure 2b) by subtracting the line width of a monitor at high intensity from its line width at low intensity. Monitors with a poor bloom index will tend to blur as the intensity is tweaked. As mentioned earlier, blooming may also indicate a poor design. The Tatung CM-1296 displayed outstanding consistency, while the Acer 7013A, Amstrad PC14 CD, and Packard Bell PB8531VG revealed a tendency to bloom.

We rounded out our tests with a measurement of voltage regulation. A common problem with inexpensive monitors is that large areas of active pixels can cause the high-voltage power supply to go bonkers. As you add bright areas to the display image, the power supply in the monitor is required to pump out more and more current. Inadequate power supplies, common in inexpensive monitors, often cannot provide enough juice to keep the picture stable. This most often appears on the screen as bright areas that tend to shrink in size. Take away some of the bright pixels, or turn down the brightness, and the size goes back to normal. The Superspot system determines the amount of "shrink" as the brightness of an image changes.

continued

12 Mhz 286 VGA COMBO KIT

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- 1.2 Meg Floppy Drive
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16 Mhz 386SX VGA

- 80386-16SX CPU
- 1 Meg RAM
- 1.2 Meg Floppy Drive
- 1.44 Meg Floppy Drive
- 66 Meg 25 ms Hard Drive
- 16 bit VGA Board
- 14" VGA color Monitor
- 2S/1P/1G ports
- 101-key Keyboard
- Genius Mouse
- M/S DOS 4.01

$1995

20 Mhz 386 VGA

- 80386-20 CPU
- 2 Meg RAM
- 1.2 Meg Floppy Drive
- 1.44 Meg Floppy Drive
- 66 Meg 25 ms Hard Drive
- 16 bit VGA Board
- 14" VGA color Monitor
- 2S/1P/1G ports
- 101-key Keyboard
- Genius Mouse
- M/S DOS 4.01

$2395

25 Mhz 386 VGA

- 80386-25 CPU
- 2 Meg RAM
- 1.2 Meg Floppy Drive
- 1.44 Meg Floppy Drive
- 66 Meg 25 ms Hard Drive
- 16 bit VGA Board
- 14" VGA color Monitor
- 2S/1P/1G ports
- 101-key Keyboard
- Genius Mouse
- M/S DOS 4.01

$2495

25 Mhz CACHE 386 VGA

- 80386-25 CPU
- 32K 25ns Cache Memory
- 4 Meg RAM
- 1.2 Meg Floppy Drive
- 1.44 Meg Floppy Drive
- 150 Meg 18 ms ESDI Drive
- 32K Fast Cache ESDI Controller
- 16 bit VGA Board
- 14" VGA color Monitor
- 2S/1P/1G ports
- 101-key Keyboard
- Genius Mouse
- M/S DOS 4.01

$3595

33 Mhz CACHE 386 VGA

- 80386-33 CPU
- 32K 25ns Cache Memory
- 4 Meg RAM
- 1.2 Meg Floppy Drive
- 1.44 Meg Floppy Drive
- 150 Meg 18 ms ESDI Drive
- 32K Fast Cache ESDI Controller
- 16 bit VGA Board
- 14" VGA color Monitor
- 2S/1P/1G ports
- 101-key Keyboard
- Genius Mouse
- M/S DOS 4.01

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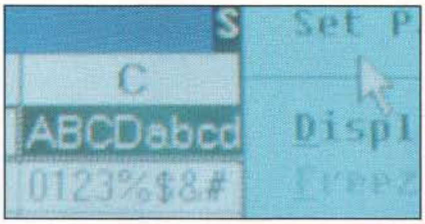
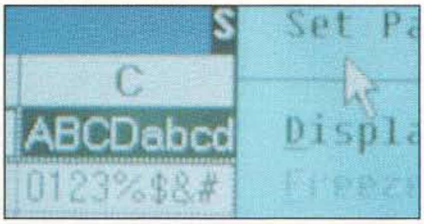
Screen Sampler

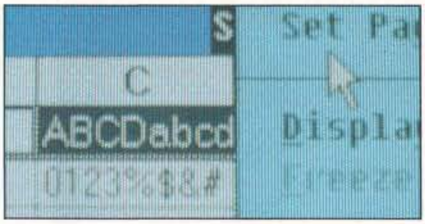
These photos show portions of each of the 26 monitors. Poor spot size is evident in the worst displays, resulting in a grainy appearance. The photos are approximately 35 percent larger than the actual screen.



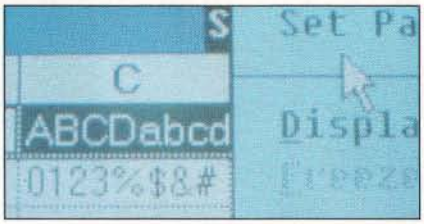
Epson A804031



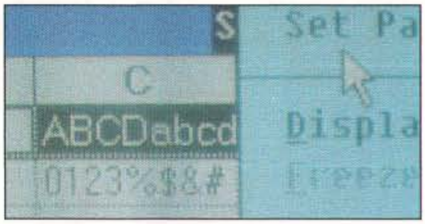
Mitsuba 710V



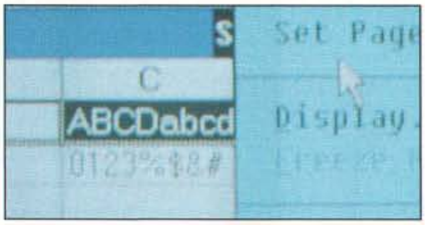
IBM 8512



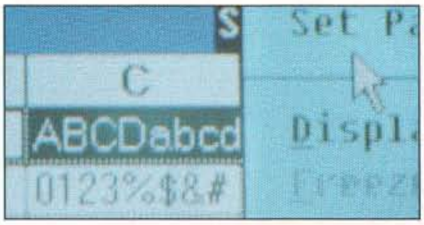
Mitsubishi XC1429CH



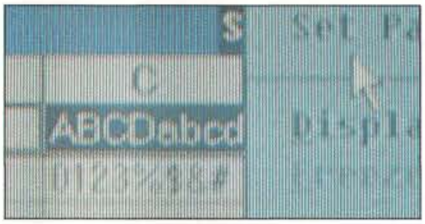
Acer 7013A



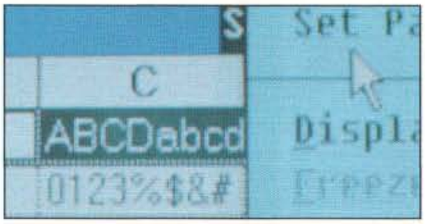
IBM 8513



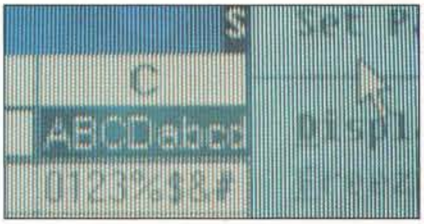
Packard Bell PB8531VG



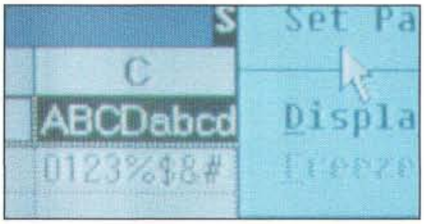
Amstrad PC14 CD



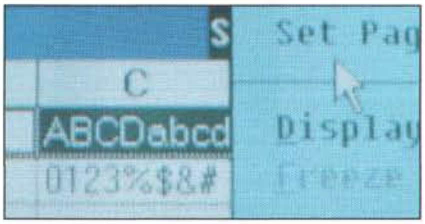
Imtec 1430V



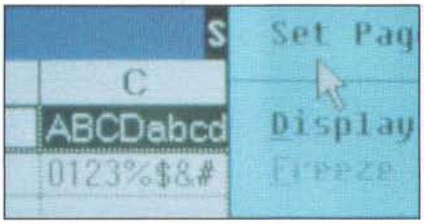
Packard Bell PB8552VG



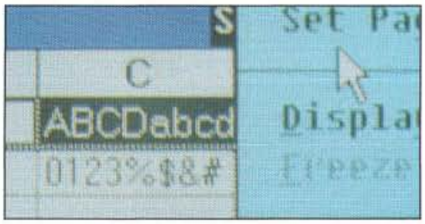
Amstrad PC14 HRCD



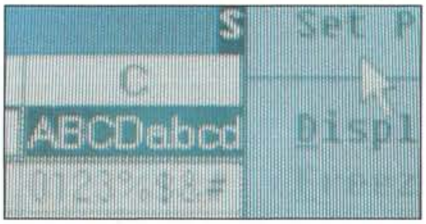
Laser 6448



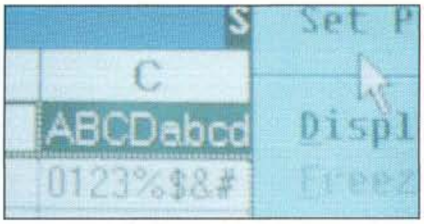
Princeton PSC-28



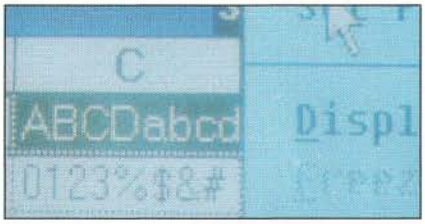
AST ASTCVGA



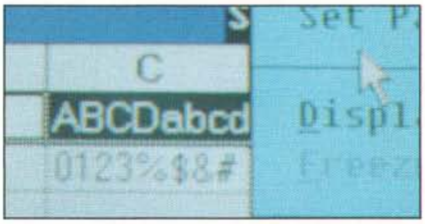
Magnavox CM9032



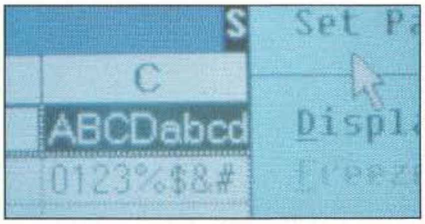
Quimax DM-3114



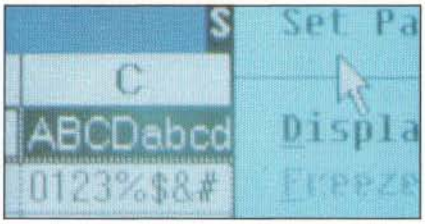
CTX CVG-5432



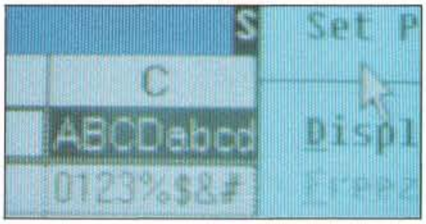
Magnavox Pro 9CM082



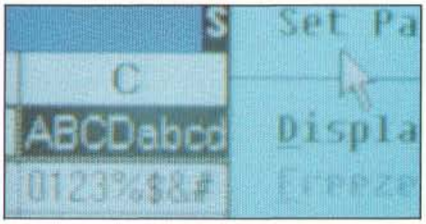
Relisys RE9513



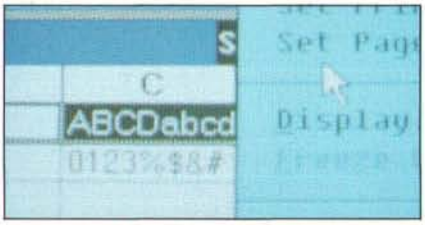
Samsung CJ4681



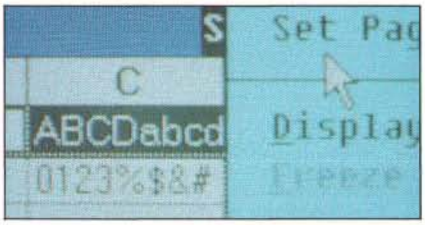
Tandy VGM 200



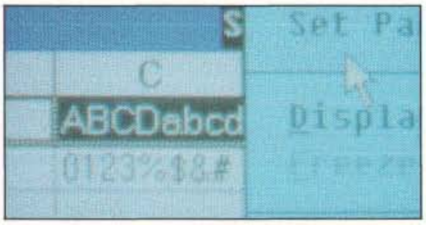
Tandy VGM 300



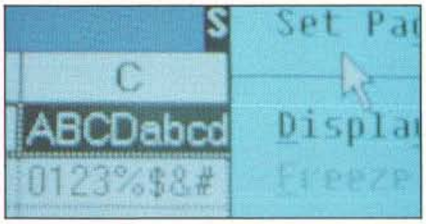
Tatung CM-1296



Tatung CM-1496



Wyse WY650



Zenith ZCM-1390

To gauge this effect, we displayed a line at the top of the screen and then measured its displacement as the screen changed from black (all bits off) to white (all bits on). We also took a measurement at the left side of the screen. Although we did not graph these test results, the AST ASTCVGA, CTX CVG-5432, Epson A804031, and Princeton PSC-28 turned in poor results. The best voltage regulation was achieved by the IBM and Tandy monitors.

Bringing It All Together: The VGA Index

So what does it all mean? We have tabulated this conglomeration of objective data and tried to put it in a format that is easy to grasp. The result is our VGA index (see figure 3). Those monitors with the longest bars deliver superior overall performance. We have also listed the monitors according to price (the most inexpensive monitor at the top, the most expensive at the bottom) so that you can make some simple price/performance judgments. Long bars at the top reveal outstanding deals, while short bars at the bottom reveal monitors that tested poorly yet carry expensive price tags. For example, although the Zenith ZCM-1390 and the Laser 6448 share roughly the same performance index, the Laser monitor offers a superior price/performance mix.

To tabulate the VGA index, we assigned a weight to each of the other indexes. Line width and misconvergence each received a weighting of 3, since we believe those factors will more heavily determine the image quality. Both of those measurements can tell you a lot about how well a monitor is designed. We gave the variance index a weighting of 2, and since we deemed jitter to be the most annoying defect, it received a weighting of 1, while swim and drift were each weighted at ½. We gave the bloom index a weighting of 1. We then calculated the geometric mean of the weighted results to establish the final VGA index for each monitor. We employed the same basic formula used to derive our system application index.

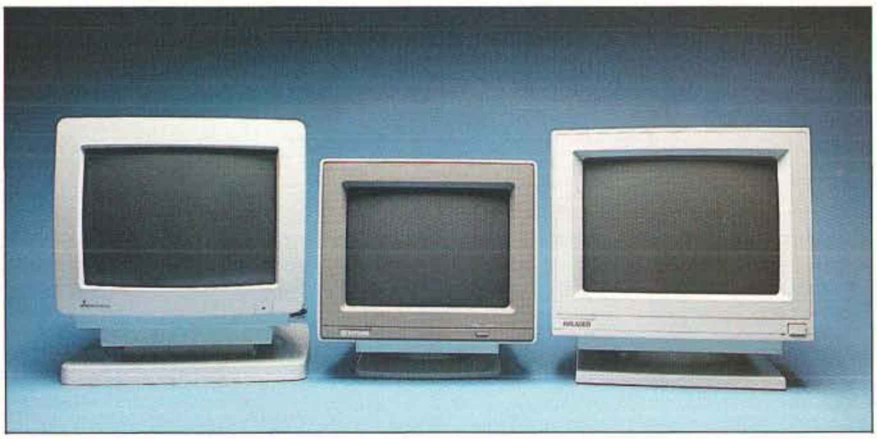
The Human Touch

As good as our testing equipment is, it cannot replace your own subjective tastes and unique needs. When you go out to buy a VGA monitor, keep in mind the applications that you'll use.

If possible, you may want to bring your application disks with you when you shop around. Even if your applications are limited to traditional text-based software (word processing and spreadsheets), you should take a look at some graphical applications as well. The next release of your software will probably incorporate some graphical features. Most of the popular word processors are incorporating features like preview mode, which will exploit a monitor's graphics capabilities. Some word processors also use the higher resolution of VGA to deliver 43 or 50 lines per screen. The latest version of Borland's Quattro and a forthcoming product from Lotus Development (Lotus 1-2-3/G) are bringing a graphical interface to those spreadsheets. With this in mind, you should try to take a look at packages such as Microsoft Windows or Quarterdeck's DESQview before buying. As a starting point, the photos at left show output samples for each of the 26 monitors.

Even more important is the hardware that you'll run with your monitor. Two monitors, the Packard Bell PB8531VG

continued



Three of the best: (from left to right) the Laser 6448, the Tatung CM-1296, and the Mitsubishi XC1429CH.

COMPANY INFORMATION

Acer America Corp.
(7013A)
401 Charcot Ave.
San Jose, CA 95131
(408) 922-0333
Inquiry 1071.

Amstrad
(PC14 CD, PC14 HRCD)
1915 Westridge Dr.
Irving, TX 75038
(214) 518-0668
Inquiry 1072.

AST Research
(ASTCVGA)
2121 Alton Ave.
Irvine, CA 92714
(714) 756-4945
Inquiry 1073.

CTX International, Inc.
(CVG-5432)
161 Commerce Way
Walnut, CA 91789
(714) 595-6146
Inquiry 1074.

Epson America
(A804031)
2780 Lomita Blvd.
Torrance, CA 90505
(800) 922-8911
(213) 539-9140
Inquiry 1075.

IBM
(8512, 8513)
Old Orchard Rd.
Armonk, NY 10504
(914) 765-1900
Inquiry 1076.

Laser Computer, Inc.
(6448)
800 North Church St.
Lake Zurich, IL 60047
(708) 540-8086
Inquiry 1077.

Leading Technology
(Imtec 1430V)
10430 Southwest Fifth St.
Beaverton, OR 97005
(800) 999-5323
Inquiry 1078.

Mitsuba Corp.
(710V)
650 Terrace Dr.
San Dimas, CA 91773
(714) 592-2866
Inquiry 1079.

Mitsubishi Electronics
(XC1429CH)
991 Knox St.
Torrance, CA 90502
(213) 515-3993
Inquiry 1080.

Packard Bell
(PB8531VG, PB8552VG)
9425 Canoga Ave.
Chatsworth, CA 91311
(818) 773-9521
Inquiry 1081.

Philips Consumer Electronics Co.
(Magnavox CM9032,
Magnavox Pro 9CM082)
One Philips Dr.
P.O. Box 14810
Knoxville, TN 37914
(615) 521-4316
Inquiry 1082.

Princeton Graphics
(PSC-28)
1100 Northmeadow Pkwy.,
Suite 150
Roswell, GA 30076
(800) 221-1490
Inquiry 1083.

Quimax Systems, Inc.
(DM-3114)
Troy Office Center
1259 Route 46 E, Building #4
Parsippany, NJ 07054
(201) 334-0019
Inquiry 1084.

Relisys
(RE9513)
320 South Milpitas Blvd.
Milpitas, CA 95035
(408) 945-9000
Inquiry 1085.

Samsung Information Systems
(CJ4681)
3655 North First St.
San Jose, CA 95134
(800) 624-8999
Inquiry 1086.

Tandy Corp.
(VGM 200, VGM 300)
1700 One Tandy Center
Fort Worth, TX 76102
(817) 390-3011
Inquiry 1087.

Tatung Co. of America
(CM-1296, CM-1496)
2850 El Presidio St.
Long Beach, CA 90810
(800) 421-2929
(213) 637-2105
Inquiry 1088.

Wyse Technology
(WY650)
3471 North First St.
San Jose, CA 95134
(800) 438-9973
(408) 473-1200
Inquiry 1089.

Zenith Data Systems
(ZCM-1390)
1000 Milwaukee Ave.
Glenview, IL 60025
(800) 553-0331
(312) 699-4800
Inquiry 1090.

and the Zenith ZCM-1390, would not sync correctly with the VGA card made for our Superspot system. They ran fine, however, when we substituted a Genoa Super VGA card. If your system already includes a VGA component, make sure that it will drive the monitor you select. Otherwise, solicit suggestions from your dealer or the manufacturer to determine the best card to go with your new monitor.

Ultimately, you need to follow your own instincts. Take a good look at the color quality of the monitor. Check for fuzziness in the corners. See what controls are available and how well they work. Is the intensity range sufficient? Turn the monitor into strong light and see how well it handles glare. You might even try putting it close to a source of interference (e.g., another monitor) and see how well it handles that. After all, there's no better testing equipment than your own eyes.

The Best and the Brightest

Taken as a whole, the various indexes highlight some clear winners. Both the Tatung models were impressive. The CM-1296 scored higher on our tests and carries a price tag $60 below that of the CM-1496, but the CM-1496 has a 14-inch diagonal screen, compared to the CM-1296's 12-inch screen. Our Superspot system clearly recommends the CM-1296, and we concur. It displayed vivid colors and pure white text. Another fine choice is the Mitsubishi XC1429CH (see the photo on page 137, bottom right). It, too, kept showing up at the top of our test results. At $658, it's a little more expensive, but keep in mind that street prices should be considerably lower. In any case, it's an investment that we wouldn't hesitate to make.

If you'd rather pay a little less, the Laser 6448 sports a list price that's $159 less than the Mitsubishi XC1429CH and still posts good numbers on our tests. In general, we were impressed with the quality of the monitors, and VGA prices continue to fall. If you're still living in a monochrome world, perhaps it's time to become a card-carrying member of the VGA revolution. ■

Stanford Diehl and Howard Eglowstein are testing editors for the BYTE Lab. They can be reached on BIX as "sdiehl" and "heglowstein," respectively.

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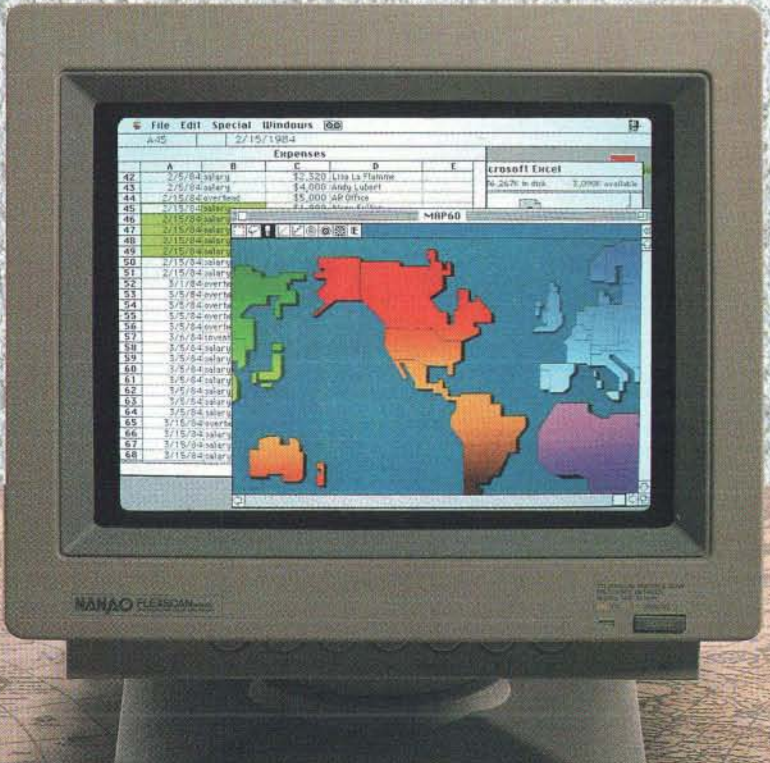
Circle 197 on Reader Service Card (DEALERS: 198)



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Scan Frequency : Automatic Adjustment
H: 15.5kHz-38.5kHz
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Front-mounted controls for easy access.
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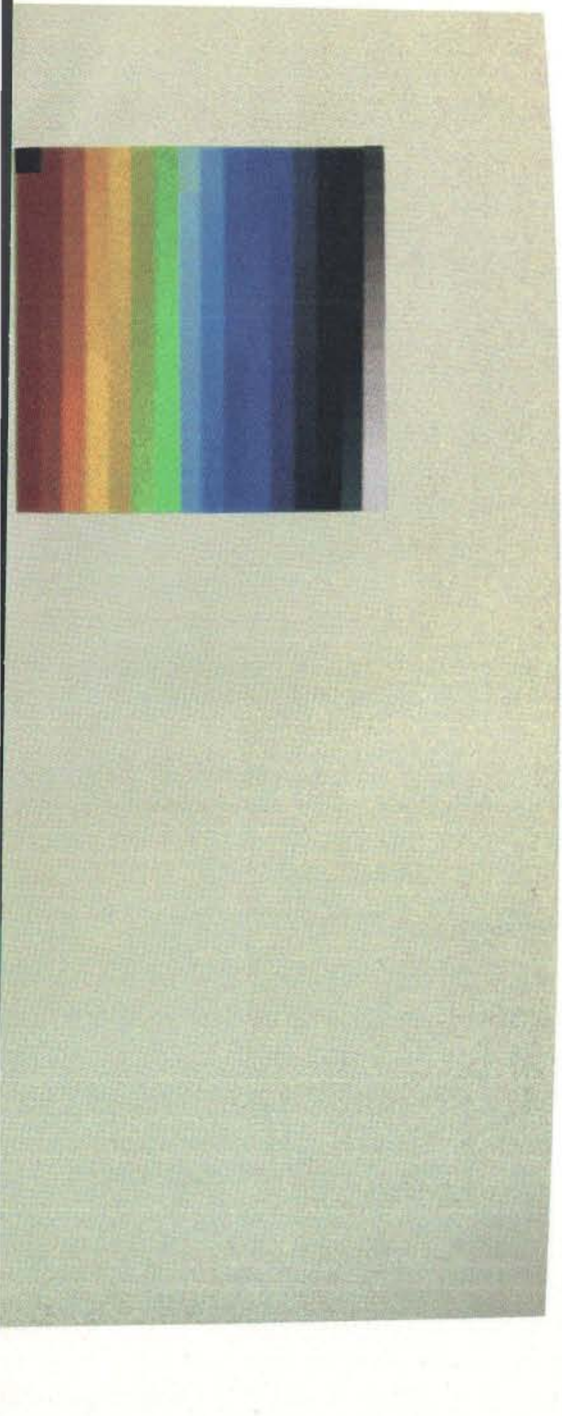
Most VGA monitors this colorful,

Image created on the Samsung VGA-GraphicMaster™ color monitor using RIX Softworks, Inc. Software.
Unretouched photograph. © 1989, Samsung Information Systems America, Inc.

cost 20% more.



The Monarch butterfly is one of Mother Nature's most splendid creations.

And as you can see, Samsung's new high resolution VGA color monitor vividly brings to life its rich colors and striking contrasts.

Capable of displaying an unlimited palette of colors, the VGA-Graphic Master's™ 14-inch screen with 640 x 480 resolution creates images of superb quality. The tight .31mm dot pitch keeps everything from graphics to type super-clear and razor sharp.

Add to that convenient, up-front controls, a nonglare screen and tilt-swivel base for comfortable viewing, and you've got an array of features that add up to a monitor costing hundreds more.

But this, of course, should come as no surprise. Because along with outstanding performance, Samsung has for years enjoyed a reputation for unmatched value and reliability. All of which have gone a long way toward making Samsung the world's largest monitor maker, with over 8 million units sold.

So if you're looking for high performance, for a lot less, take a good look at Samsung.

For literature or the name of your nearest Samsung distributor, call 1-800-446-0262.

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Circle 247 on Reader Service Card
(DEALERS: 248)

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PC WORLD
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Monitor - Model	Resolution	Frequency	List
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EGA/CGA - 5154	640 x 200,350	15.75,21.85 kHz	$699
Multiscan - 5155	800 x 600	15.5-35 kHz	$799
VGA Color - 9513	720 x 480	31.5 kHz	$699
VGA Gray Scale - 9503	800 x 480	31.5 kHz	$249

TEFAX RA-2110	for Apple Macintosh $1595	for IBM $1495

RELISYS
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Circle 239 on Reader Service Card (DEALERS: 240)

Inexpensive SXes by Mail

80386SX systems fulfill the promise of 80386 power at low prices

Mark L. Van Name and Bill Catchings

The Gateway 386SX (left) and the PC Brand 386/SX-16.

As the 80286 versus 80386SX debate goes on, PC clone vendors are announcing 80386SX systems in droves. Two such systems, Gateway 2000's 386SX and PC Brand's 386/SX-16, offer a great deal of power at very reasonable prices. Both products are available directly from the vendor via mail order.

Our evaluation versions of these machines show just how much you can get in a low-cost 80386SX system. Each unit included a 16-MHz 80386SX and an 80387SX math coprocessor, 8 megabytes of memory, a 40-megabyte hard disk drive, a 5¼-inch 1.2-megabyte floppy disk drive, a 3½-inch 1.44-megabyte floppy disk drive, two serial ports, one parallel port, a 101-key keyboard, and a 16-bit VGA adapter with 512K bytes of video RAM. Both also came with multisync monitors: Gateway 2000's CrystalScan 860 (made by Tatung) and, with the PC Brand 386/SX-16, an NEC MultiSync 2A. The Gateway 386SX used a standard AT-size case and included MS-DOS 4.01. The PC Brand 386/SX-16 came in a minitower chassis that included two more options: a 40-megabyte tape backup unit and a Microsoft-compatible bus mouse. PC Brand sells MS-DOS 4.01 separately.

The cost? Only $3445 for the Gateway and $3943 for the PC Brand.

Those figures suggest that the Gateway is about $500 cheaper than the PC Brand—but it's not that simple. To make a price comparison, you have to configure systems as similarly as possible.

For one thing, Gateway 2000 began offering a 65-megabyte run-length-limited (RLL) Microscience hard disk drive with its standard 386SX configuration as this review went to press. A PC Brand system with a comparable hard disk drive—the 386/SX-16 with a 66-megabyte, modified-frequency-modulation (MFM) MiniScribe drive with a 25-millisecond access time—costs an additional $225. Further, PC Brand includes shipping in the cost of each system, so we should add Gateway 2000's $75 shipping charge to its unit's price. Finally, we must subtract the costs of the extras on the PC Brand evaluation unit: the tape drive, the mouse, and the minitower case (an AT-size case is standard). The resulting comparison prices are $3520 for the Gateway and $3884 for the PC Brand—a difference of only $364.

There are still more cost games you can play. While Gateway 2000 provides its multisync CrystalScan monitor standard with its base system, PC Brand includes a plain VGA monitor; the NEC MultiSync 2A added $120 to our unit's cost. If you don't need a multisync monitor, you can go with the standard VGA monitor and save the $120, lowering the price difference to $244. If you want a tape drive, Gateway's 40-megabyte unit is an additional $325, while PC Brand's is only $199, bringing the two units $126 closer. Both vendors also offer many other configurations and options.

So, while the Gateway is cheaper, the exact cost difference between these two

continued

Gateway 386SX

Company
Gateway 2000
106 West Eighth St.
P.O. Box 2000
Sergeant Bluff, IA 51054
(800) 233-8472
(712) 943-2000

Components
Processor: 16-MHz Intel 80386SX; socket for 16-MHz Intel 80387SX math coprocessor
Memory: 2 megabytes of 80-ns DRAM in two 1-megabyte SIMMs, expandable to 8 megabytes on the motherboard; 128K bytes of BIOS ROM
Mass storage: 5¼-inch 1.2-megabyte TEAC floppy disk drive; 3½-inch 1.44-megabyte TEAC floppy disk drive; 40-megabyte 28-ms Seagate hard disk drive
Display: Gateway 2000 CrystalScan 860 color 13-inch, multisync VGA monitor; ATI VGAWonder-16 16-bit VGA card
Keyboard: 101-key IBM Enhanced layout
I/O interfaces: One 9-pin and one 25-pin serial port; one 25-pin parallel port; six 16-bit and two 8-bit AT-style expansion slots

Options tested
6 megabytes of 80-ns DRAM in six 1-megabyte SIMMs: $750
16-MHz 80387SX: $350
Additional 256K bytes of DRAM on 16-bit VGA board: $50

Price
Base system: $2295
System as reviewed: $3445

Inquiry 851.

PC Brand 386/SX-16

Company
PC Brand, Inc.
954 West Washington
Chicago, IL 60607
(312) 226-3500

Components
Processor: 16-MHz Intel 80386SX; socket for 16-MHz Intel 80387SX math coprocessor
Memory: 512K bytes of 80-ns DRAM in 256K-byte SIPs, expandable to 8 megabytes on the motherboard; 128K bytes of BIOS ROM
Mass storage: 5¼-inch 1.2-megabyte Mitsumi Electric floppy disk drive; 3½-inch 1.44-megabyte TEAC floppy disk drive; 40-megabyte MiniScribe hard disk drive
Display: NEC color 13-inch, VGA MultiSync 2A monitor; ATI VGAWonder-16 16-bit VGA card
Keyboard: 101-key modified IBM Enhanced layout
I/O interfaces: One 9-pin and one 25-pin serial port; one 25-pin parallel port; five 16-bit and three 8-bit AT-style expansion slots

Options tested
Model with 40-megabyte hard disk drive and 16-bit VGA card with color VGA monitor: $1937 ($848 over base)
Minitower case: $50
NEC MultiSync 2A monitor (replacing the standard VGA color monitor): $120
8-megabyte memory upgrade: $1120
16-MHz 80387SX: $275
Additional 256K bytes of DRAM on 16-bit VGA board: $72
3½-inch 1.44-megabyte floppy disk drive: $80
MS-DOS 4.01: $55
Microsoft-compatible mouse: $35
Colorado Memory Systems 40-megabyte tape drive: $199

Price
Base system: $1089
System as reviewed: $3943

Inquiry 852.

machines depends on the specific configuration you choose.

Performance and Compatibility

The two machines also turned in remarkably close results on BYTE's system benchmarks. The Gateway 386SX had an overall application index of 11.2, while the PC Brand 386/SX-16 was just behind it with an application index of 10.6. For comparison, the Compaq 386s had an application index of 11.5; the Gateway lagged behind it by a mere 3 percent, the PC Brand by 8 percent.

The main reason that these systems lost to the Compaq 386s is disk speed. On BYTE's raw disk benchmark, the Compaq beat the Gateway by about 16 percent and the PC Brand by nearly 30 percent. Both machines actually beat the Compaq on the raw CPU tests by about 30 percent. The Gateway's now-standard 65-megabyte Microscience RLL drive should improve its performance somewhat, but the message is clear: For maximum speed, you should order these machines with faster hard disk drives.

Besides performing well, both systems passed our compatibility tests with flying colors. On the software side, they successfully ran all our test programs, including Borland's Paradox/386 2.03, Quattro 1.0, SideKick Plus 1.00A, SuperKey 1.16A, Turbo C 2.0, and Turbo Pascal 4.0; Digitalk's Smalltalk 1.2; Foresight's Drafix CAD Ultra 3.03C; Lotus 1-2-3 release 2.2; MicroPro's WordStar 4.0; Microsoft's Windows/386 2.0 and Word 4.0; Novell's NetWare 2.15; Peter Norton's Norton Utilities 3.00; the public domain Kermit 2.32/A; Quarterdeck Office Systems' DESQview 2.00 and Expanded Memory Manager 386 1.10; Symantec's Q&A 1.1; Wolfram's Mathematica 1.2; and WordPerfect's WordPerfect 5.0. The success with Paradox/386, Windows/386, Drafix CAD Ultra, and Mathematica is particularly worth noting; those programs use DOS extenders and 80386 instructions that exercise the 80386SX CPU far more than conventional DOS programs do. Both systems worked with all our test hardware, including an internal Western Digital WD8003 Ethernet adapter, a Microsoft Serial Mouse, and an external Xircom Pocket Ethernet Adapter.

Going Inside

The Gateway and the PC Brand perform and test so similarly largely because they are remarkably alike on the inside. Sure, their cases look very different—the AT-size chassis of the Gateway seems huge next to the PC Brand's minitower—but this is just an illusion. The heart of each machine is its motherboard, and PC Brand offers the same Trump motherboard in its standard AT-size case as in our minitower evaluation unit.

The Gateway 386SX's FTK motherboard is a modest 8½ inches wide by 13 inches deep. A few years ago, it would have seemed a wonderful piece of engineering; today, it's just another small motherboard. Highlighting its 51 nonmemory chips are four key chips from Chips & Technologies' NEAT (New Enhanced AT) chip set.

An 80387SX lay in its motherboard socket. The 80386SX was not socketed. The CPU can run at full speed (the default) or at a slower compatibility speed of 8 MHz. You can change the CPU's speed either with a turbo button on the front of the unit or from the keyboard. The turbo button worked, but its status light didn't change.

The unit's 8 megabytes of 80-nanosecond memory was in eight 1-megabyte single in-line memory modules (SIMMs) that provided parity checking and were

continued

Gateway 386SX, PC Brand 386/SX-16

APPLICATION-LEVEL PERFORMANCE

WORD PROCESSING	Gateway	PC Brand
XyWrite III+ 3.52	**Med./Large**	**Med./Large**
Load (large)	:13	:14
Word count	:04/:26	:04/:26
Search/replace	:06/:27	:06/:27
End of document	:02/:16	:02/:16
Block move	:10/:10	:10/:10
Spelling check	:11/1:21	:11/1:21
Microsoft Word 4.0		
Forward delete	:17	:17
Aldus PageMaker 1.0a		
Load document	:10	:11
Change/bold	:26	:31
Align right	:27	:23
Cut 10 pages	:20	:20
Place graphic	:05	:05
Print to file	2:22	2:31
🟥 **Index:**	**2.24**	**2.21**

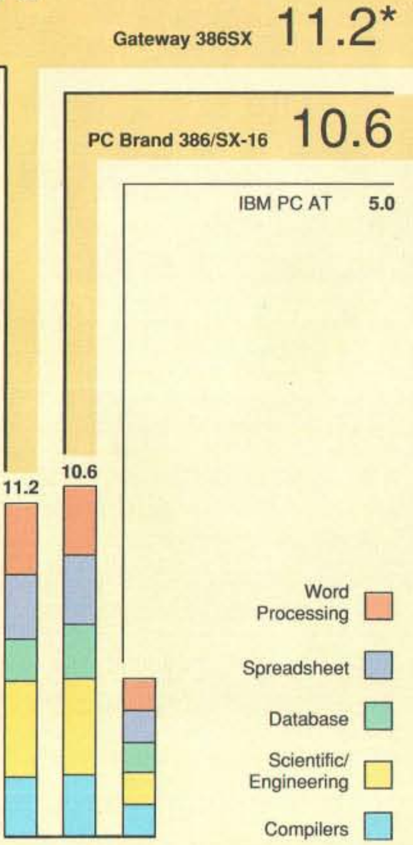
SPREADSHEET	Gateway	PC Brand
Lotus 1-2-3 2.01		
Block copy	:04	:04
Recalc	:02	:02
Load Monte Carlo	:18	:15
Recalc Monte Carlo	:06	:06
Load rlarge3	:05	:04
Recalc rlarge3	:01	:01
Recalc Goal-seek	:04	:04
Microsoft Excel 2.0		
Fill right	:06	:06
Undo fill	2:30	2:34
Recalc	:02	:02
Load rlarge3	:31	:28
Recalc rlarge3	:02	:02
■ **Index:**	**2.11**	**2.17**

DATABASE	Gateway	PC Brand
dBASE III+ 1.1		
Copy	1:29	1:14
Index	:20	:08
List	1:20	1:14
Append	2:30	2:38
Delete	:03	:04
Pack	1:23	1:39
Count	:17	:04
Sort	1:25	1:09
🟩 **Index:**	**1.32**	**1.77**

SCIENTIFIC/ ENGINEERING	Gateway	PC Brand
AutoCAD 2.52		
Load SoftWest	:56	:54
Regen SoftWest	:43	:44
Load StPauls	:13	:13
Regen StPauls	:07	:08
Hide/redraw	14:17	14:42
STATA 1.5		
Graphics	:31	:31
ANOVA	:12	:12
MathCAD 2.0		
IFS 800 pts.	:19	:20
FFT/IFFT 1024 pts.	:19	:19
🟨 **Index:**	**3.06**	**3.00**

COMPILERS	Gateway	PC Brand
Microsoft C 5.0		
XLisp compile	4:59	5:02
Turbo Pascal 4.0		
Pascal S compile	:06	:05
🟦 **Index:** ·	**1.89**	**2.01**

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT=1.



*Cumulative application index. Graphs are based on indexes at left and show relative performance.

LOW-LEVEL PERFORMANCE[1]

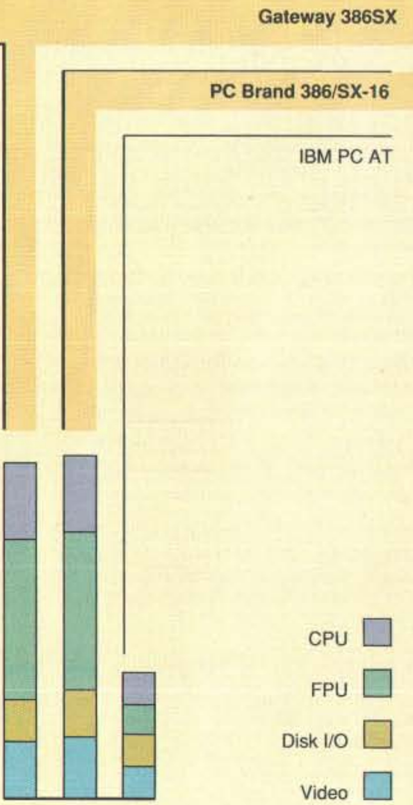
CPU	Gateway	PC Brand
Matrix	6.79	6.81
String Move		
Byte-wide	26.71	26.58
Word-wide:		
Odd-bnd.	36.14	36.14
Even-bnd.	13.38	13.35
Doubleword-wide:		
Odd-bnd.	26.20	26.16
Even-bnd.	13.37	13.35
Sieve	32.94	32.83
Sort	31.45	31.40
■ **Index:**	**2.43**	**2.44**

FLOATING POINT	Gateway	PC Brand
Math	11.36	11.15
Error[2]		
Sine(x)	3.19	3.21
Error		
e^x	3.40	3.50
Error		
🟩 **Index:**	**5.07**	**5.04**

DISK I/O	Gateway	PC Brand
Hard Seek[3]		
Outer track	4.47	3.33
Inner track	4.31	3.30
Half platter	9.99	13.34
Full platter	13.30	19.96
Average	8.02	9.98
DOS Seek		
1-sector	16.65	18.77
32-sector	31.65	30.60
File I/O[4]		
Seek	0.15	0.21
Read	1.24	0.87
Write	1.07	1.07
1-megabyte		
Write	5.68	3.97
Read	5.55	2.95
🟨 **Index:**	**1.37**	**1.50**

VIDEO	Gateway	PC Brand
Text		
Mode 0	5.05	4.50
Mode 1	5.05	4.51
Mode 2	4.56	4.12
Mode 3	4.56	4.12
Mode 7	N/A	N/A
Graphics		
CGA:		
Mode 4	2.53	2.55
Mode 5	2.58	2.52
Mode 6	2.52	2.48
EGA:		
Mode 13	4.92	4.78
Mode 14	4.86	4.83
Mode 15	N/A	N/A
Mode 16	4.89	4.83
VGA:		
Mode 18	5.05	5.07
Mode 19	2.54	2.53
Hercules	N/A	N/A
🟦 **Index:**	**1.81**	**1.92**

CONVENTIONAL BENCHMARKS	Gateway	PC Brand
LINPACK	249.63	255.73
Livermore Loops[5] (MFLOPS)	0.1154	0.1085
Dhrystone (MS C 5.0) (Dhry./sec.)	4065	4065



N/A=Not applicable.

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[1] All times are in seconds. Figures were generated using the 8088/8086 and 80386 versions (1.1) of Small-C.

[2] The errors for Floating Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.

[3] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).

[4] Read and write times for File I/O are in seconds per 64K bytes.

[5] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

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mounted in four pairs on the motherboard. The NEAT chips implemented a two-way interleaved memory architecture that let the system run without wait states most of the time. One consequence of this approach, however, is that you can install memory only in identical banks. The NEAT chips can handle total system memory configurations of 512K bytes or 1, 2, 4, or 8 megabytes.

The PC Brand's motherboard used the same four NEAT chips. It was even about the same size (8 inches wide by 13½ inches deep) as the one in the Gateway. It was, however, a more modern-looking board, with fewer nonmemory chips (44) and more surface mounting than the Gateway's motherboard.

Its 80387SX was also socketed; its 80386SX was not. As it used the same four NEAT chips, the PC Brand offered the same CPU compatibility speed and memory architecture as the Gateway. The PC Brand's turbo button, however, did not work. A PC Brand spokesperson said the company was aware of this and pointed out that you could still change the CPU speed from the keyboard.

The PC Brand's memory also ran at 80 ns and had parity checking. Its memory came in eight 1-megabyte single in-line packages (SIPs) rather than the SIMMs used in the Gateway.

The motherboards shared one other characteristic: Both had expansion slots arranged so that cards in them would run between and very close to the memory modules. In the PC Brand, for example, an expansion card in one slot was actually touching two memory SIPs. Spokespersons for both vendors said that this tight fit should not cause any trouble, and we had no problems with our review units. Still, it seems risky for anything to be touching a memory module.

Another common component of both systems is the BIOS. Both use the same 128K-byte, 150-ns, 4/30/89 ROM BIOS from American Megatrends, Inc. AMI's BIOS products have become increasingly popular among PC clone vendors, and for good reasons. This BIOS displays a full screen of system information when you boot, and it contains some excellent and easy-to-use diagnostics.

Finally, both systems offer eight expansion slots. The Gateway has six 16-bit and two 8-bit slots, all full-length. The PC Brand has five 16-bit and three 8-bit slots; all are full-length except for two of the 8-bit slots.

Mass Storage

Both units have almost identical complements of mass storage devices, although the PC Brand contained a tape backup unit, while the Gateway did not. The two machines even used the same TEAC 3½-inch floppy disk drive. Both also had five total drive bays. All five in the Gateway were 5¼-inch half-height openings, while only two in the PC Brand were that size; the other three were 3½-inch half-height slots. (But if you buy PC Brand's full-size desktop case, you get the same drive bay options as in the Gateway.)

Despite these many mass storage similarities, the hard disk drive in the PC Brand beat the one in the Gateway by about 10 percent on BYTE's raw disk performance tests. The PC Brand uses a 40-megabyte MiniScribe RLL drive with an average access time of only 45 ms. The Gateway's 40-megabyte Seagate hard disk drive has a faster 28-ms average access time, but it is a standard MFM, not RLL, drive. These results will probably change, however, if you buy the Gateway with the 65-megabyte RLL Microscience drive.

Video and Keyboard

The similarities between these two machines continue with their video adapters: both used ATI's VGAWonder-16 16-bit VGA card with 512K bytes of video memory installed. The PC Brand beat the Gateway on video performance, however, because it was using a newer version of the ATI card. The PC Brand VGA card also included a bus mouse controller and connector that were missing from the card in the Gateway.

The two multisync monitors are also similar, but for our taste the NEC MultiSync 2A had a slightly better picture.

Both systems have keyboards that follow the 101-key IBM Enhanced keyboard layout. The Gateway's Key Tronic keyboard implements that layout exactly; the PC Brand's keyboard (by Mitsumi Electric) uses the common modified layout in which the Enter key is larger.

Software and Documentation

Not surprisingly, these two systems also offer similar standard software and documentation. The Gateway includes the FTK Trump-386 Utility Software. The PC Brand includes the PC Brand 286/12-20 and 386/SX Utility Software and the Ontrack Disk Manager/Disk Manager Diagnostics disk. Both systems come with manuals for the systems themselves and for the utility programs (although the documentation for the Ontrack utilities consists of just a few lines on the disk sleeve). The manuals for both machines include all the information

continued

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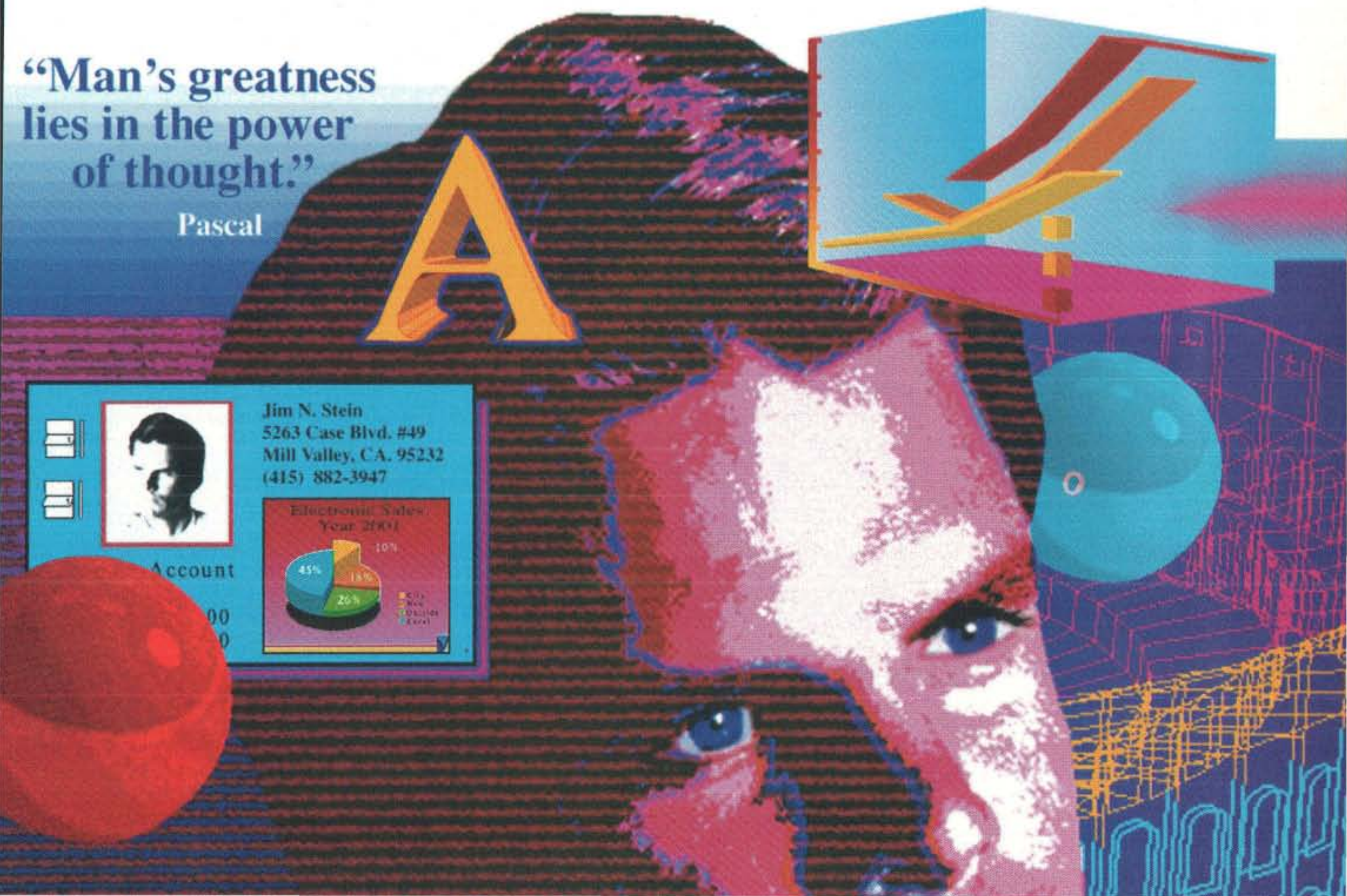

you're likely to need. Both vendors also included manuals for all the components—disk drives, VGA card, and monitor—with their systems.

We were pleasantly surprised, however, by the high quality of DOS support that both vendors offered. Gateway 2000 includes MS-DOS 4.01 or 3.3 (your choice) with each system. You have to buy DOS 4.01 separately from PC Brand, but it costs only $55. So far, nothing special. If you buy DOS, however, both vendors install it on your hard disk for you. That's a good service that all vendors should supply.

After the Purchase

Both vendors also offer strong support plans: toll-free technical-support and main telephone numbers, and on-site service for the first year. To keep down their service costs, both vendors will try to guide you through problem diagnosis and repair over the phone–they'll mail you replacement boards if you are willing to install them—but both will dispatch a service person to your site if necessary. They even use the same service firm, TRW Nationwide Service.

We also had good luck with both technical-support staffs. All the technical-support people for both firms with whom we spoke were able to answer all our questions, from the simplest to the most complex. We had some trouble reaching Gateway 2000's technical-support staff and had to leave a message for a support person to call us back, but a staff member always called within an hour.

In addition to the high quality of their basic support programs, both vendors also offer additional support features. Both have a 30-day money-back guarantee. Gateway 2000 also has a support BBS. Finally, each PC Brand system comes with a five-year prorated limited warranty. The firm pays 100 percent of all repair costs the first year, 80 percent the second, and so on, down to 20 percent during the fifth year. Only the first year automatically includes on-site service, but you can buy additional years of on-site service for about $100 per year.

80286 or 80386SX?

With their support options, Gateway 2000 and PC Brand make it clear that you don't have to be an industry leader to treat your customers right. We applaud them for offering standard on-site service and toll-free support lines. We also like the performance and compatibility of their systems. If, however, you're shopping around for a low-cost, high-performance system, the real question is, do you need an 80386SX, or will a fast 80286 meet your needs?

If you want to run software designed for the 80386 and you're on a tight budget, check out these machines. They're fast and inexpensive, and they have excellent support programs.

If you just want a fast processor, however, then you can still find cheaper comparable 80286 systems—but the gap is narrowing fast. With Intel trumpeting the demise of the 80286, we expect to see more 80386SX systems like these rapidly approaching the prices of the high-end 80286 systems. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.

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109	Centronics 350/351/352/353	9.35
118	Citizen LSP 120D/180D	4.95
169	Citizen MSP 10/20	2.75
167	Citizen MSP 15/25	3.85
123	Comrex 420	7.55
131D	Data Products B-300/600	5.45
280	Epson EX 800/1000	4.65
165	Epson FX/MX/RX 70/80/85	2.75
167	Epson FX/MX/RX 100/185/286	3.85
288	Epson Lq500/Lq800/Lq850H.D.	3.85
289	Epson Lq1000 H.D./Lq1050	4.95
163	Epson Lq1500	3.25
281	Epson Lq2500 H.D.	4.95
283	Epson Lq2550	4.95
283C	Epson Lq2550 4 color	23.00
287	Epson Lq950	4.60
175	Epson LX 80/90	2.75
145	Hewlett Packard 2631A	12.05

No.	Description	Price Ea. (Black)
181	IBM 3287/3615 SD Loop	1.95
195	IBM 3287/3619 SD Cart.	2.75
188	IBM 4201 ProPrinter II	4.15
176	IBM 4202 ProPrinter XL	4.95
177	IBM 4207 ProPrinter X24	4.95
211	IBM 4208 ProPrinter XL24	6.35
184	IBM 4224	11.25
875	IBM 4234	22.95
286	Mannesmann Tally 85	4.35
285	Mannesmann Tally 86	4.95
204	Mannesmann Tally 120/160	3.35
205	Mannesmann Tally 140/180	3.85
660	NEC Pinwriter P1/P2/P6	3.95
661	NEC Pinwriter P3/P7	4.35
662	NEC Pinwriter P5/P9	4.35
663	NEC P2200 H.D.	6.05
210	NEC 5200/5300 Nylon	5.95
210M	NEC 5200/5300 M/S	11.75
210C	NEC 5200/5300 4 color	23.00
209	Okidata 182/183/192/193/ 320/321	3.95
206	Okidata 292	5.35
208	Okidata 293/294	6.15

No.	Description	Price Ea. (Black)
212	Okidata 393	17.95
215	Panasonic KXP 1124	4.95
217	Panasonic KXP 1080/1091	3.95
220	Panasonic KXP 1524	7.95
226	Radio Shack DMP 400/LPVI	3.25
235	Radio Shack DMP100/LPVII	4.35
282	Radio Shack/DMP 130	4.15
282	Seikosha SP800/1000	4.15
261	Star Micronics NB/NL/NP/NX 10	3.95
264	Star Micronics NL/NP/NX 15	5.75
266	Star Micronics NX1000	3.65
266C	Star NX1000 4 color	9.85
267	Star Micronics NX2400	4.75
262	Star Micronics Radix10/SR10	3.95
263	Star Micronics Radix15/SR15	4.55
290	Star Micronics SD10	4.15
291	Star Micronics SD15	4.55
245	Toshiba P321/P351	3.45
245	Toshiba P1340/P1350/P1351	3.45
246	Toshiba P321SL/P341SL	5.05
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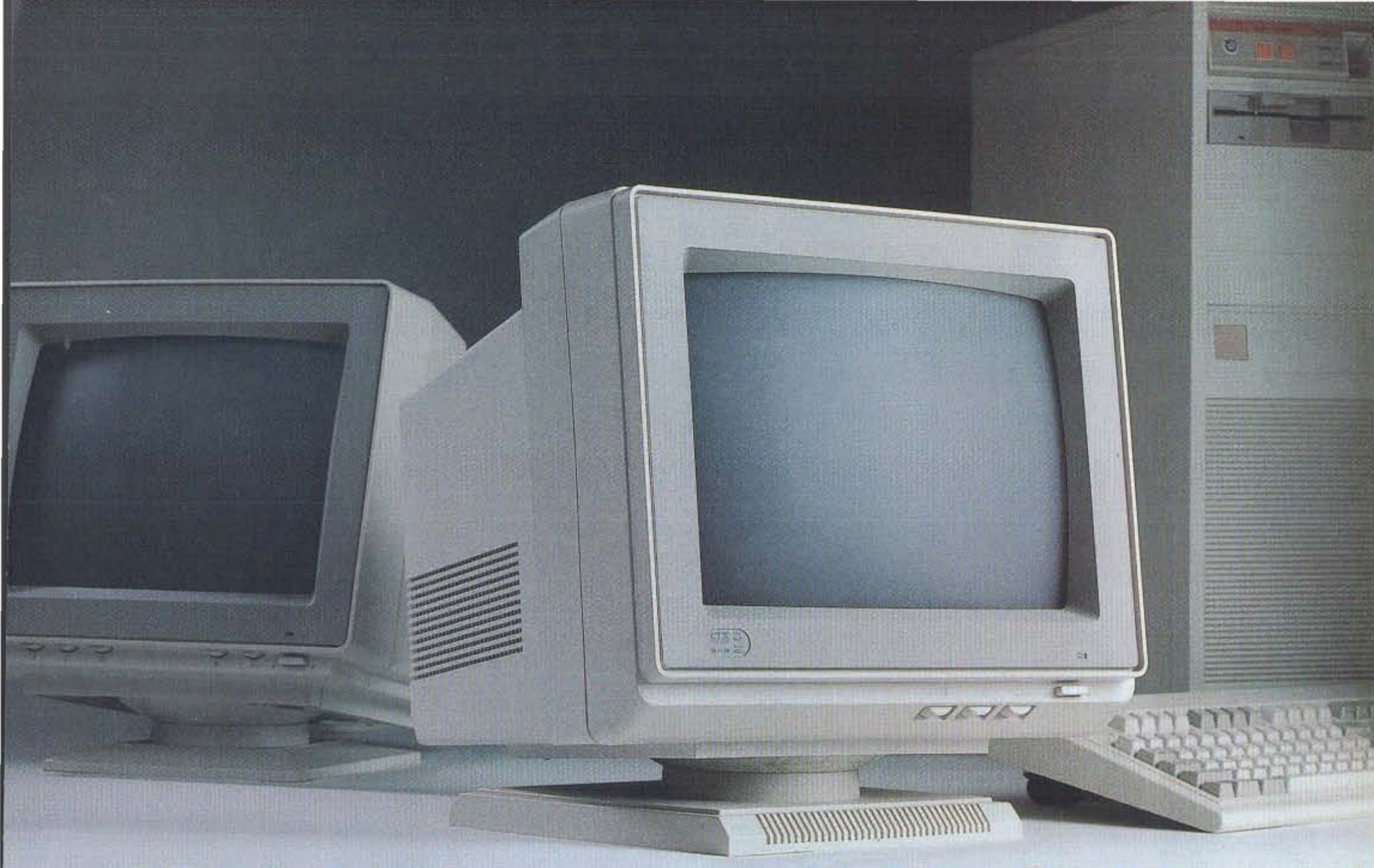

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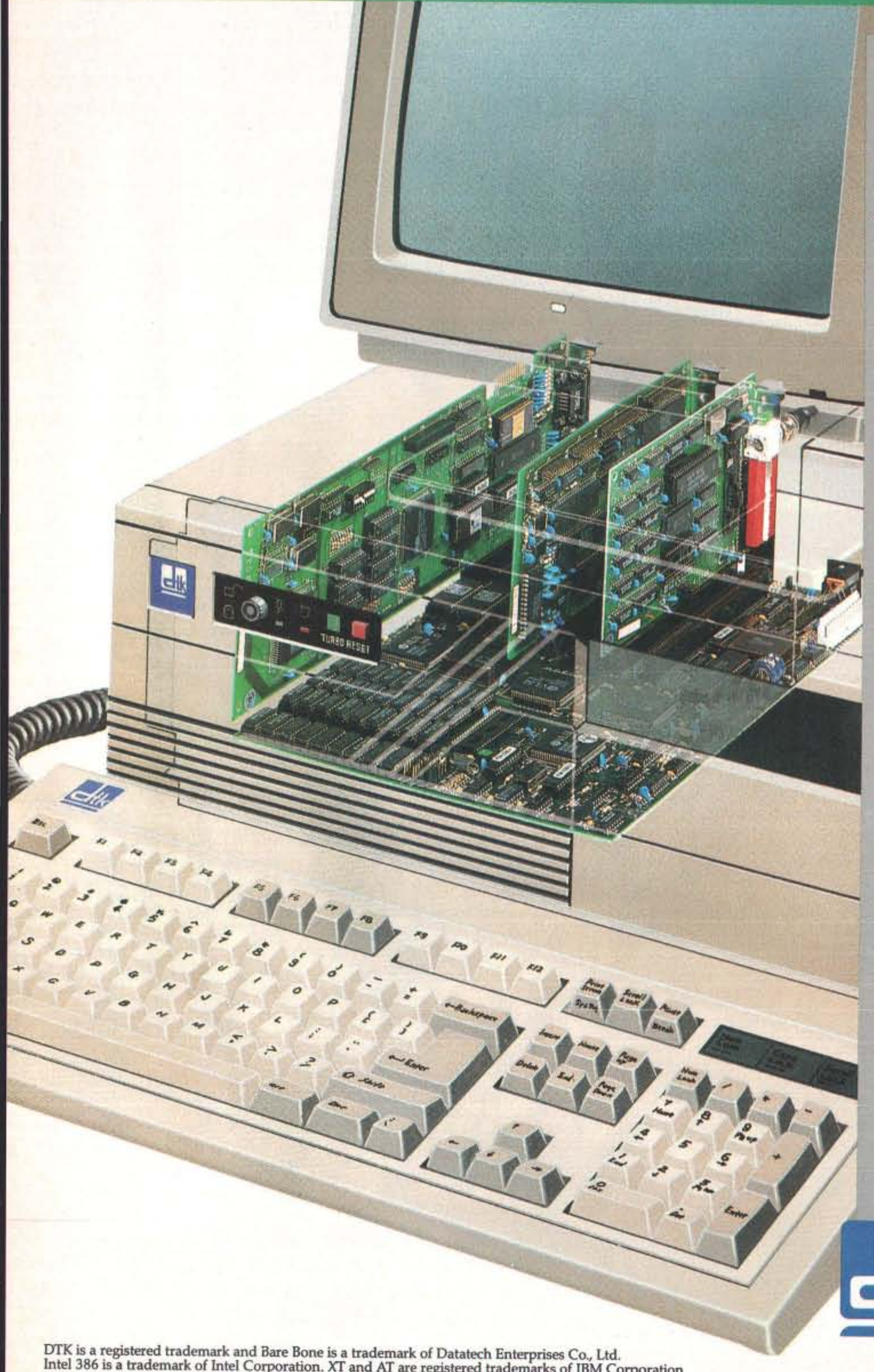

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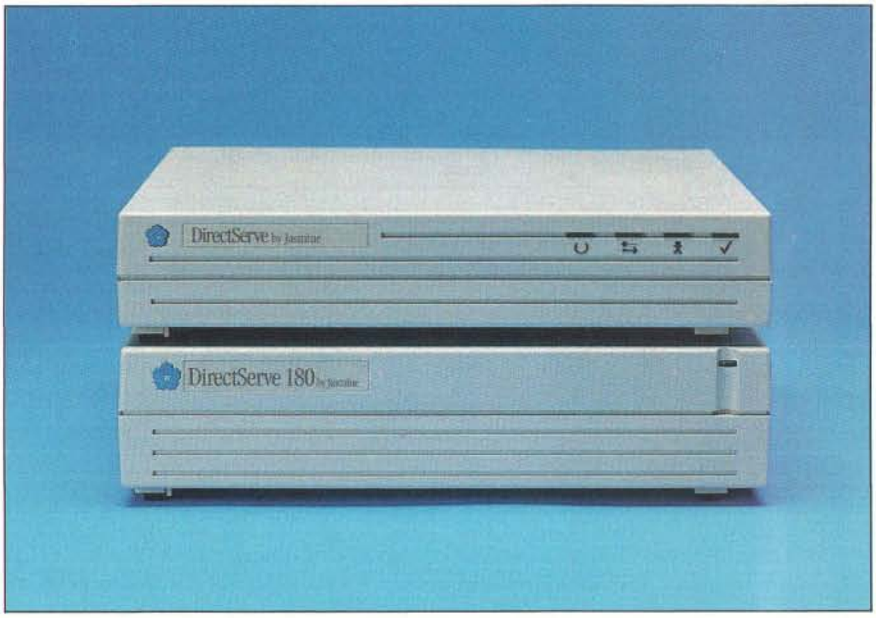
AppleShare Without a Mac

Jasmine's DirectServe provides low-cost relief for Macs that languish as AppleShare file servers

Don Crabb



Jasmine's DirectServe (top) and DirectServe 180.

The most popular network file-server technology in the Macintosh market is Apple's own AppleShare. It succeeds because it resides on a Mac to provide true file, volume, and account access control for all the disk volumes. Unfortunately, a complete and expensive Mac must be dedicated solely to this task.

Jasmine's new DirectServe promises all the benefits of a Macintosh/AppleShare server without hogging a valuable Mac. The DirectServe is a hardware file server that uses AppleShare-compatible software and a Macintosh-compatible file system to store, retrieve, and control Mac files just like an AppleShare server. But at $1795 (without a disk drive), the DirectServe is thousands of dollars less expensive than Macintosh/AppleShare combinations, while offering comparable performance.

50 Users

The DirectServe is a compact plastic box that is roughly the size of Jasmine's DirectDrive hard disk drives. Its start-up sequence loads the server software from an attached hard disk volume, pushing the software into cache memory. Once the server has been loaded, it mounts all the attached disk drives, and the system notifies the attached LocalTalk network that it's alive and well. The DirectServe supports a network of 50 active users and handles up to seven daisy-chained SCSI hard disk drives.

SCSI hard disk drives attach to the supplied rear-panel DB-25 SCSI port, and LocalTalk connects through the supplied rear-panel DIN-8 port. Unfortunately, the DirectServe does not support any alternate twisted-pair Ethernet wiring schemes, so you must use LocalTalk-compatible wiring. This limits the bandwidth to 230K bytes per second. Although the DirectServe does not support EtherTalk or any other kind of Ethernet wiring, SCSI alternate wiring cards may be available in the future.

The DirectServe is not a Mac, even though its hardware design is similar to one (see figure 1). It doesn't include the Mac ROMs, Toolbox, or Hierarchical File System (HFS). Instead, it provides its own operating system, which I found to be compatible with AppleShare 2.01 and the AppleTalk Filing Protocol 2.0. Since the DirectServe provides only file service, its 10-MHz Motorola 68010 CPU performs quite nicely.

My biggest hassle in setting up the DirectServe came when I copied all the files to its attached disks. Since they are not HFS-compatible, you can't hook the disks up to a Mac for a quick direct SCSI copy. Instead, you have to pump it all across LocalTalk—not the most pleasant of alternatives. Copying my 40-megabyte set of application files to the DirectServe took almost 2 hours. Still, once this initial setup is done, loading new software should be a lot less onerous.

I couldn't back up the server by directly attaching a tape drive because DirectServe doesn't recognize HFS volumes. Likewise, CD-ROM and digital-audio-tape drive HFS file systems aren't DirectServe-compatible. Also, DirectServe won't run concurrent applications,

continued

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so I couldn't use it as an E-mail server or as a print spooler.

Test Results

I connected the DirectServe to a Jasmine DirectServe 180 hard disk drive (a Jasmine 180-megabyte DirectDrive with DirectServe software already installed). Then I linked the server to a 12-node LocalTalk network consisting of 10 Mac Pluses, one Mac IIcx, and one Mac II. I copied applications software from the Mac IIcx across the network to the server and then established user accounts and groups on the server.

I tested file access, remote application launching, file updating, and other basic functions from each workstation. The DirectServe worked just like an AppleShare 2.01 server. To verify this, I removed the DirectServe and loaded AppleShare 2.01 onto the Mac IIcx and performed the same basic tests. I noted few substantive differences.

For the record, I performed all my tests on the second DirectServe that I received from Jasmine. My original review unit was defective, and my best efforts to resuscitate it failed.

Figures 2 and 3 show the results of my speed tests, file searches, and sequential searches through a database, plus the time necessary to index the database file. The tests of single and repeated file operations from a single workstation node show that the DirectServe was the slowest of my four configurations. This distinction is to be expected, especially with the DirectServe 180-to-local disk drive comparisons. I attribute the DirectServe's slowness to the AppleTalk/LocalTalk network, not to the server's internals. Even with this slowdown, the DirectServe compared favorably with the AppleShare/Mac IIcx network.

Unfortunately, these benchmarks do a poor job of testing the DirectServe's response when all nodes on the network are blasting packets around. Jasmine claims that, in most instances, the DirectServe/DirectServe 180 is about twice as fast as a Mac Plus/AppleShare network and almost as fast as a Mac IIcx/AppleShare network. The DirectServe actually becomes comparatively faster than a Mac IIcx server as network loading increases, which I confirmed in my own informal testing on a 12-node network.

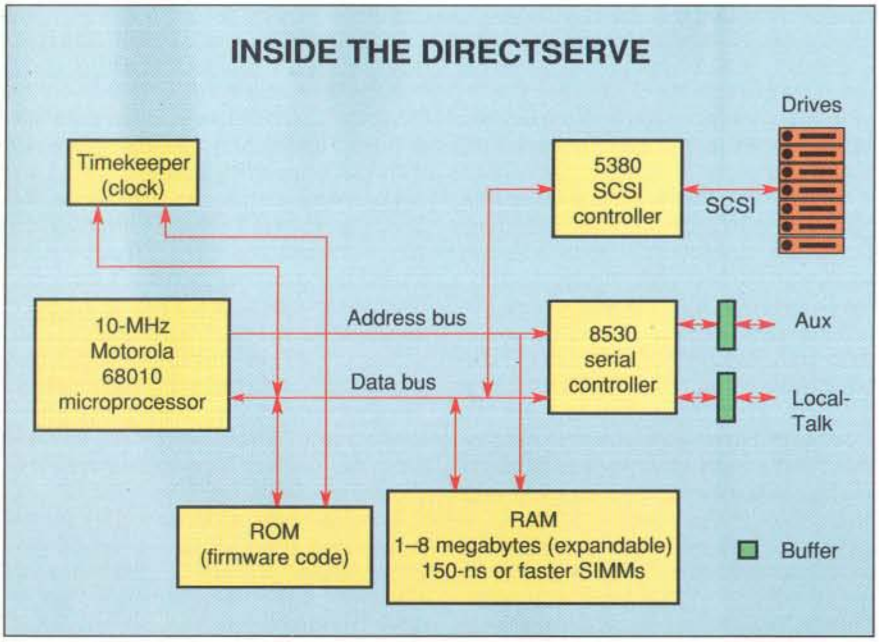

Figure 1: *The DirectServe's 68010 CPU incorporates an instruction cache. SCSI and AppleTalk logic ensures compatibility with standard Macintosh peripherals.*

Specialty Software

The DirectServe file system is designed for only one purpose: to provide file service. As such, it excels, given the constraints of AppleTalk/LocalTalk. The software automatically sets data blocks at a 4K-byte page size, which is optimum for AppleTalk packetization. This means that the DirectServe always fills the LocalTalk pipeline to full without overflowing it and without wasting bandwidth. Also, DirectServe administrative software (akin to AppleShare's Administrator application) easily finds files on the disk, thanks to special disk data structures on the server disks.

The DirectServe operating system loads into the system RAM cache when the server boots (1 megabyte comes standard, and you can upgrade to 8 megabytes). About 450K bytes of that 1 megabyte holds the operating system, and the rest is available for a processor cache to maximize the processor hit rate. The attached SCSI disk drives and the AppleTalk port can also use this cache memory to improve throughput.

Cached data remains in RAM until all the RAM is full. Even if the RAM data has been changed, it stays in memory. Dubbed a "Copy Back" cache design, it further reduces disk access. By contrast, the Mac uses RAM caching to improve performance, which doesn't help as much in a file server situation. Also, a Mac maxes out at 1.4 megabytes of cache as a file server, while the DirectServe can go to 7.5 megabytes when you have installed all 8 megabytes of cache RAM.

The DirectServe cannot be administered directly, since it's a headless design lacking keyboard, mouse, and screen. Instead, its administration software consists of two programs, the Installer and the Administrator. Any Mac connected to the DirectServe (and running AppleShare Workstation software and the Jasmine Administrator software) can administer the file server.

The Installer disk initializes any hard disk that the DirectServe will use (it supports Jasmine and most other SCSI disk drives) and transfers the DirectServe operating system to the server volume. Since the DirectServe's operating system is not HFS-compatible, a DirectServe

continued

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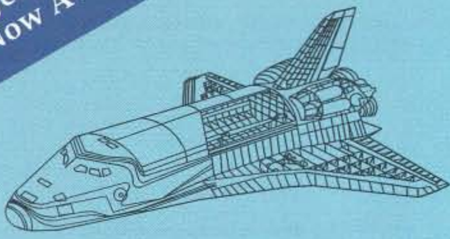
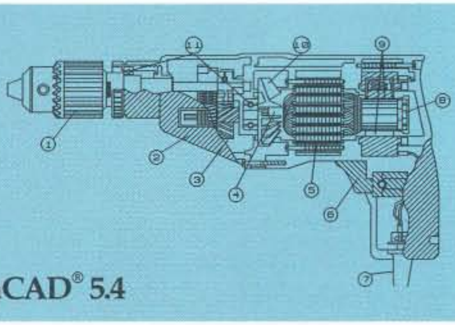
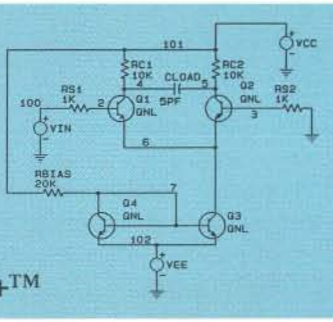
 **AutoCAD® Release 10**	15 seconds	3 minutes 17 seconds	1 minute 2 seconds
 **VersaCAD® 5.4**	49 seconds	9 minutes 45 seconds	3 minutes 11 seconds
 **Schema II+™**	17 seconds	5 minutes 15 seconds	2 minutes 13 seconds

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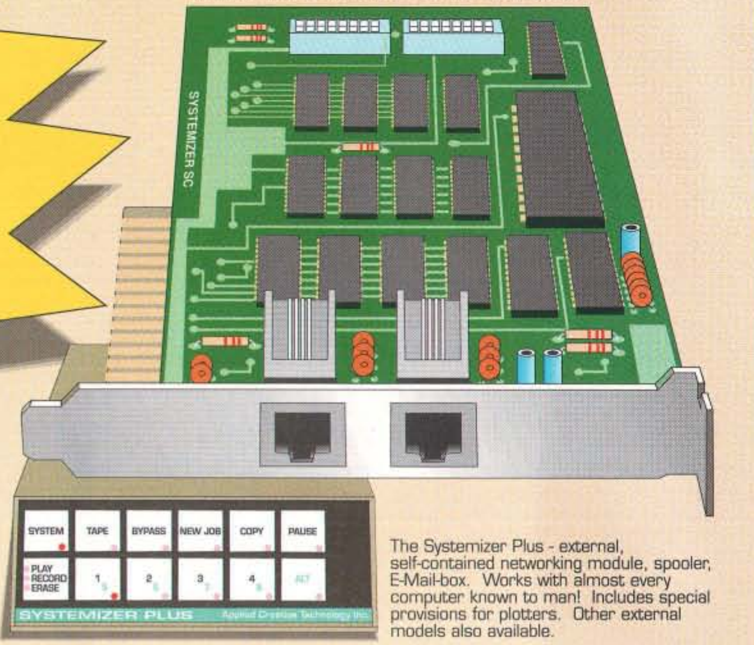

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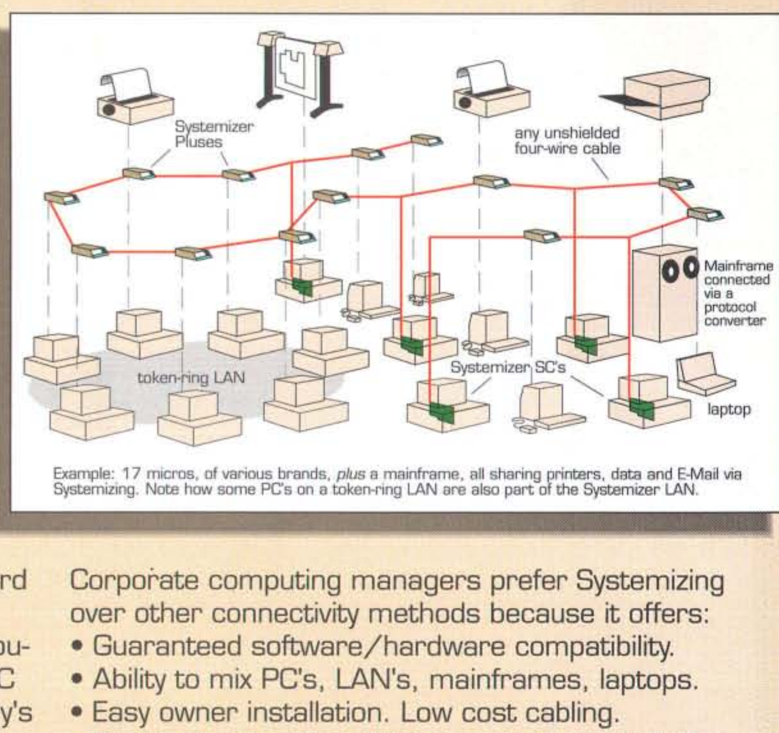
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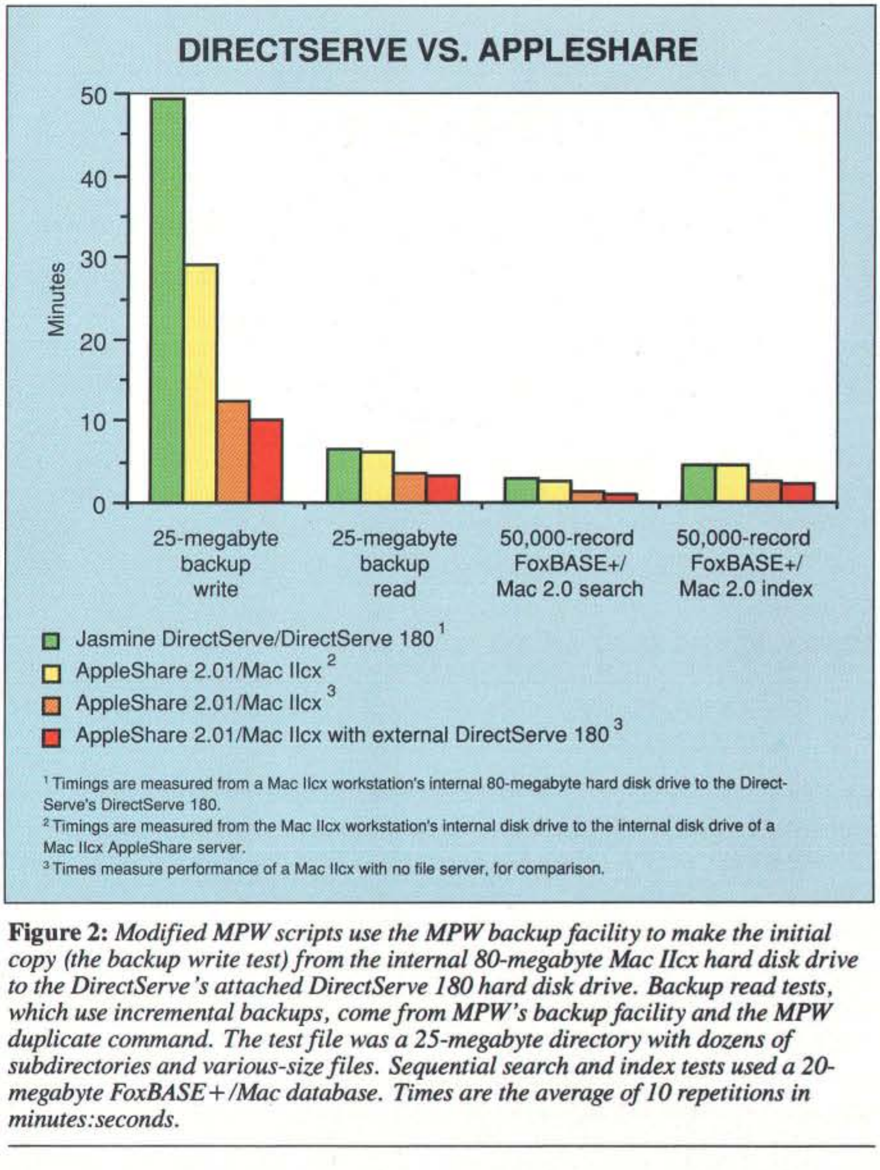

[1] Timings are measured from a Mac IIcx workstation's internal 80-megabyte hard disk drive to the DirectServe's DirectServe 180.

[2] Timings are measured from the Mac IIcx workstation's internal disk drive to the internal disk drive of a Mac IIcx AppleShare server.

[3] Times measure performance of a Mac IIcx with no file server, for comparison.

Figure 2: *Modified MPW scripts use the MPW backup facility to make the initial copy (the backup write test) from the internal 80-megabyte Mac IIcx hard disk drive to the DirectServe's attached DirectServe 180 hard disk drive. Backup read tests, which use incremental backups, come from MPW's backup facility and the MPW duplicate command. The test file was a 25-megabyte directory with dozens of subdirectories and various-size files. Sequential search and index tests used a 20-megabyte FoxBASE+/Mac database. Times are the average of 10 repetitions in minutes:seconds.*

volume cannot be used directly by a Mac without being reinitialized.

The Administrator software performs the same kind of housekeeping functions as the AppleShare administrator. It adds, deletes, and modifies users, groups, and passwords. It also retrieves network diagnostic information. But the Administrator lacks several AppleShare features, including the ability to show current log-ins and to copy-protect individual files. Of course, the AppleShare Administrator runs only from the server, so it's less convenient for network administration.

On the whole, the Jasmine software works much like AppleShare from both an administrator's and a workstation user's point of view. I didn't miss the additional AppleShare features. DirectServe uses the same password/group/user accounting scheme as AppleShare does, so network security is comparable on the two platforms.

Economical, for Some

The DirectServe competes directly with TOPS, Novell NetWare/Mac, 3Com 3+, and other Mac-compatible file servers. But its real challenge is a Mac running AppleShare. Based on price/performance, DirectServe is a winner: A DirectServe with a Jasmine DirectServe 180 costs $2799 (the DirectServe alone is $1795), while a Mac IIcx with an external DirectServe 180 (and no internal hard disk drive) costs nearly $7000. Of course, the Mac IIcx is a general-purpose computer, and the DirectServe is not. Still, the comparison is important if you only need AppleShare file service.

I was quite surprised by how fast the

continued

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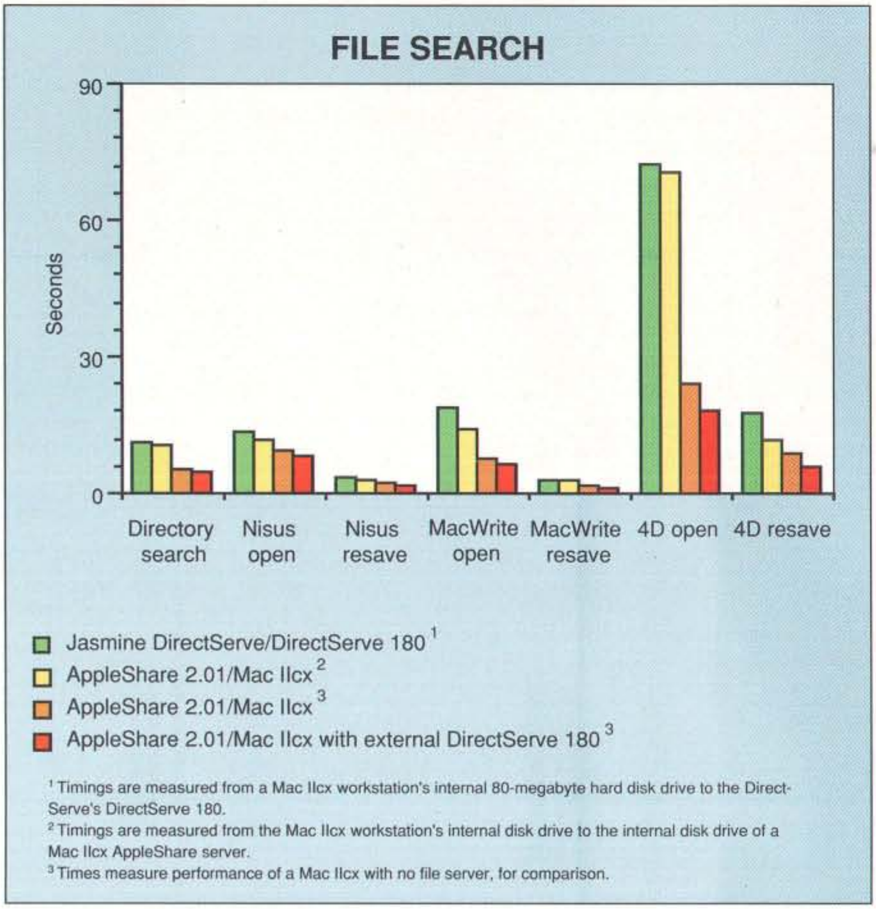

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[2] Timings are measured from the Mac IIcx workstation's internal disk drive to the internal disk drive of a Mac IIcx AppleShare server.

[3] Times measure performance of a Mac IIcx with no file server, for comparison.

Figure 3: *The benchmarks use MPW's* `Whereis` *command to search for a nonexistent file and report the time necessary to zip through the benchmark folder. In addition, I timed file opening and resaving using a 30K-byte Nisus file, a 70K-byte MacWrite II file, and a 2.5-megabyte 4th Dimension file. Times are the average of 10 repetitions in seconds.*

DirectServe performed. For many installations, its speed makes it a perfectly satisfactory server. It's much faster than a Mac Plus or SE server and far cheaper than a Mac IIcx. I suspect that increasing the DirectServe's cache memory could eliminate some disk-bound I/O slowdowns, although the ultimate bottleneck in any LocalTalk network is its 230K-byte-per-second bandwidth.

Keep in mind that Jasmine will play catch-up as Apple revises its software. Still, software upgrades should be easy with Jasmine's one-button installer. Jasmine promises to stay committed to upgrading the DirectServe so it's always compatible with the latest Mac system and networking software. Even if Jasmine upgrades the DirectServe's firmware, the changes should be made available as system patches on floppy disks.

Another consideration is your network cabling system. The current DirectServe does not directly support media that is compatible with non-LocalTalk networks (although it works on workstations sitting on EtherTalk networks that have been bridged to LocalTalk, using a Kinetics FastPath, for example). Jasmine hints that SCSI Ethernet adapters may be sold for the DirectServe in the future. But if high network traffic requires you to run state-of-the-art AppleTalk, you'd be better off with a Mac IIci/AppleShare server hooked to an EtherTalk network.

However, if you need basic AppleShare file service and can live without concurrent applications like E-mail, the DirectServe fills the bill, especially if you can't afford to waste money on a Mac IIcx used solely for file service. ■

Don Crabb is the director of laboratories and a senior lecturer for the University of Chicago department of computer science. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

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- 2 Serial & 1 Parallel ports on std-configurations
- High Capacity System Power supply
- Real Time Clock/Calendar with 5 Year Battery
- 80287 Co-Processor Support
- AMI BIOS w/full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM and PCNET compatibility
- Built-in System Board LIM 4.0EMS hardware
- User configurable I/O timing permitting compatible operation w/older peripherals or faster I/O for newer devices
- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/6 Disk Drive bays

Options:

- Low profile Slim Line Case w/3 Disk Drives available at no extra charge (pictured above)
- Mini Size desk top Tower ® Case w/4 Disk Drive bays
- LCD or Plasma Portable
- Factory Installed RAM Upgrades
- Custom configurations w/Name Brand peripherals of your choice

PC BRAND 286/12

w/512k, Hard Disk Drive, Monitor & Video Card

Hard Drives: MB/MS	20/40	40/25	66/25	100/25
No Video	$929	$1029	$1209	$1349
Mono	$1049	$1149	$1329	$1469
VGA-Mono	$1229	$1329	$1509	$1649
VGA-Color	$1459	$1559	$1739	$1879
SVGA/Color	$1569	$1669	$1849	$1989

PC BRAND 286/16

w/512k, Hard Disk Drive, Monitor & Video Card

Hard Drives: MB/MS	20/40	40/25	66/25	100/25
No Video	$1079	$1179	$1359	$1499
Mono	$1199	$1299	$1479	$1619
VGA-Mono	$1379	$1479	$1659	$1799
VGA-Color	$1609	$1709	$1889	$2029
SVGA/Color	$1719	$1819	$1999	$2139

PC BRAND 286/20

w/512k, Hard Disk Drive, Monitor & Video Card

Hard Drives: MB/MS	20/40	40/25	66/25	100/25
No Video	$1229	$1329	$1509	$1649
Mono	$1349	$1449	$1629	$1769
VGA-Mono	$1529	$1629	$1809	$1949
VGA-Color	$1759	$1859	$2039	$2179
SVGA/Color	$1869	$1969	$2149	$2289

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24 or 36 MONTH
LEASING

AND A 5-YEAR
WARRANTY

Best "Executive Decision" System.

-Personal Computing,
Best Bargain Systems,
Dec, 1989

"The PC Brand 386/SX-16 performed at least as well as the far costlier Compaq... We simply began marveling at what is surely the biggest bargain in personal computing"

-Computer Buyer's Guide,
Cover Story, Oct, 1989

Intel 386 Technology at 286 Prices the 386SX-16 Only $899

PC BRAND 386/SX-16 $899

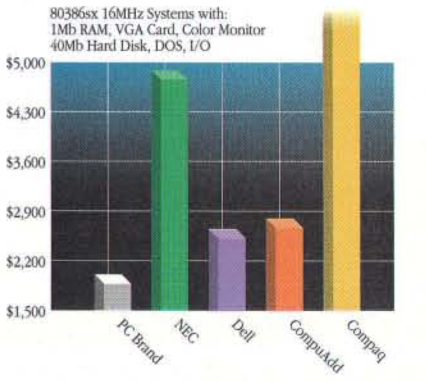
16 MHz Clock, Zero Wait Operation • Norton SI 18.7 Landmark™ 18.3MHz
512K RAM, 1.2MB or 1.44MB Drive, 101-Keyboard

Standard System Features:

- 80386SX Processor Operating at 16MHz delivering 18MHz Effective Throughput
- 512K RAM expandable to 8MB on the System board using 256K and/or 1MB RAM
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with 1024x768 capability on all VGA systems
- 1:1 Interleaved Hard/Floppy Drive controller
- Enhanced 101-key Click/Tactile Keyboard
- 2 Serial & 1Parallel ports on std-configurations
- High Capacity 200 Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80387SX Co-Processor Support
- AMI BIOS with full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM compatibility
- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/ 6 Disk Drive bays (Shown w/optional Mini Size Tower ® Case)

Options:

- Low profile Slim Line Case w/3 Disk Drive bays at no extra charge
- Mini Size desk top Tower ® Case w/4 Disk Drive bays (as pictured above)
- LCD or Plasma Portable
- Factory Installed RAM Upgrades
- Custom configurations w/Name Brand peripherals of your choice



PC BRAND 386SX-16

w/512k, Hard Disk Drive, Monitor & Video Card

Hard Drives: MB/MS	20/40	40/25	66/25	100/25
No Video	$1229	$1329	$1509	$1649
Mono	$1349	$1449	$1629	$1769
VGA-Mono	$1529	$1629	$1809	$1949
VGA-Color	$1759	$1859	$2039	$2179
SVGA/Color	$1869	$1969	$2149	$2289

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386/20
386/25...

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A SPEEDING
BULLET!"

*-Computer Shopper, Cover Story
November, 1988*

20MHz
FROM $1349
25MHz
FROM $1499

"The Best Low-Cost Alternative Around!"

-PC Magazine, 25MHz 386 PC's, Feb. 14, 1989

PC BRAND 386/20 _____ $1349

20 MHz Clock, Zero Wait Operation,
Norton SI 23.0 Landmark Speed26.1MHz,
1024K RAM, 1.2MB or 144MB Drive, 101-Keyboard

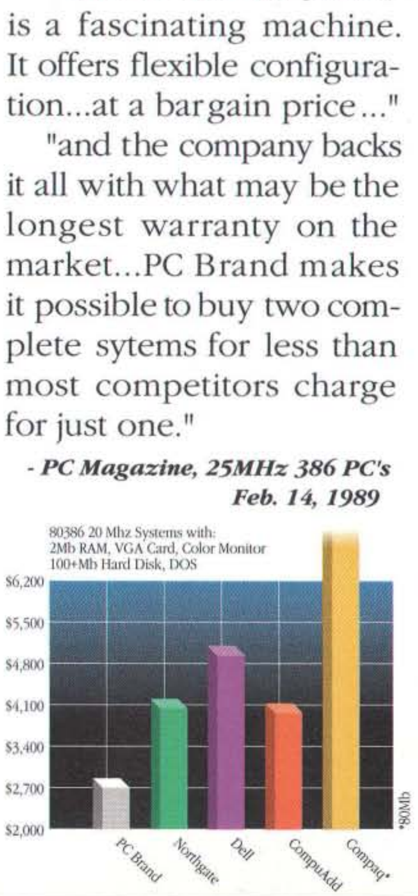
PC BRAND 386/25 ____ $1499

25 MHz Clock, Zero Wait Operation,
Norton SI 28.2-Landmark Speed 33.6MHz
Norton SI 31.6-Landmark Speed 43.5 w/Cache,
1024K RAM,1.2MB or 1.44MB Drive, 101-Keyboard

"The PC Brand 386/25 is a fascinating machine. It offers flexible configuration...at a bargain price..."

"and the company backs it all with what may be the longest warranty on the market...PC Brand makes it possible to buy two complete sytems for less than most competitors charge for just one."

***- PC Magazine, 25MHz 386 PC's
Feb. 14, 1989***



Standard System Features:

- True 20MHz or 25MHzZ Intel 80386 CPU Operating with Zero Wait States
- 1024K RAM standard expandable to 16MB using 256K and/or 1MB RAM
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with 1024x768 capability on all VGA systems
- 1:1 Interleaving Dual Hard Drive/Floppy Drive controller, 977.6 KB/SEC Caching Controller w/ESDI Configurations
- Enhanced 101-key Click/Tactile Keyboard
- 2 serial & 1 parallel ports on std-configurations
- High Capacity 200 Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80287, 80387, or Weitek Co-Processor Support
- AMI BIOS with full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM compatibility
- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/6 Disk Drive bays (as pictured above)

Options:

- Low profile Slim-Line Case w/3 Disk Drive bays available at no extra charge
- Full Size Tower ® Case w/6 Disk Drive bays
- Mini Size Tower ® Case w/4 Disk Drive bays
- LCD or VGA Plasma Portable Case
- 32k or 64k Cache upgrade (25Mhz only)
- Custom configurations w/Name Brand peripherals of your choice

PC BRAND 386/20

with Hard Disk Drive, Monitor & Video Card

Hard Drives: MB/MS	**40/25**	**66/25**	**100/25**	**200/19**
No Video	$1779	$1959	$2099	$2549
Mono	$1899	$2079	$2219	$2669
VGA-Mono	$2079	$2259	$2399	$2849
VGA-Color	$2309	$2489	$2629	$3079
SVGA/Color	$2419	$2599	$2739	$3189

PC BRAND 386/25

with Hard Disk Drive, Monitor & Video Card

Hard Drives: MB/MS	**40/25**	**66/25**	**100/25**	**200/19**
No Video	$1929	$2109	$2249	$2699
Mono	$2049	$2229	$2369	$2819
VGA-Mono	$2229	$2409	$2549	$2999
VGA-Color	$2459	$2639	$2779	$3229
SVGA/Color	$2569	$2749	$2889	$3339

"PC BRAND 386/33 HAS FLAWLESS COMPATIBILITY, LOWEST PRICE"

InfoWorld
January 8, 1990

FROM $2299

386/33 CACHE __________ $2299

33 MHz Clock, Zero Wait Operation
Norton SI 45.9 • Landmark 58.7 MHz
1024K RAM, 1.2MB or 1.44MB Drive, 101-Keyboard

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-PC Magazine, 33MHz 386 PC's, October, 31, 1989

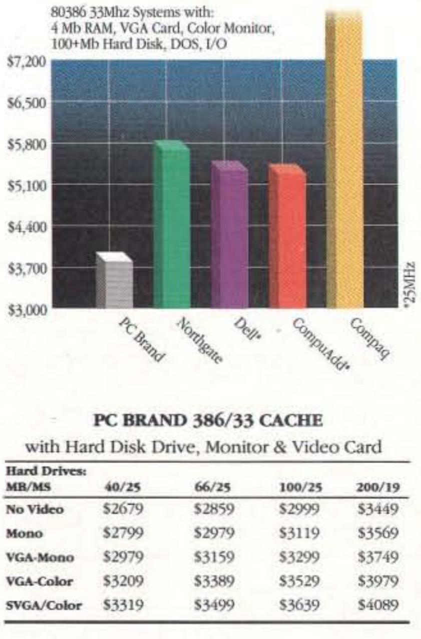
Simply put... We couldn't have said it any better ourselves!

Standard System Features:

- True 33 MHz INTEL 80386-33 CPU operating w/Zero Wait States Delivering up to 58.7 MHz Effective Throughput
- Intel 82385-33 Cache Processor with 32K 25NS Static RAM Standard, Field Upgradable to 64K
- 1024K RAM Standard Expandable to 16MB
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with 1024x768 capability on all VGA systems
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- 1:1 Interleaving Dual Hard Drive/Floppy Drive Controller, 977.6 KB/SEC Caching Controller w/ESDI Configurations
- Enhanced 101-key Click/Tactile Keyboard
- I/O Ports-2 serial,1 parallel
- High Capacity 200 Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80387 or Weitek Co-Processor support
- Phoenix BIOS with Full MS/DOS, 0S/2, XENIX, UNIX, NOVELL, 3COM compatible
- 8 Slot motherboard design
- Full size case w/6 Disk Drive bays

Options:

- Full size Tower ® Case w/6 Disk Drive bays (as shown above)
- Custom configurations w/Name Brand peripherals of your choice
- Factory Ram Upgrades



PC BRAND 386/33 CACHE

with Hard Disk Drive, Monitor & Video Card

Hard Drives: MB/MS	**40/25**	**66/25**	**100/25**	**200/19**
No Video	$2679	$2859	$2999	$3449
Mono	$2799	$2979	$3119	$3569
VGA-Mono	$2979	$3159	$3299	$3749
VGA-Color	$3209	$3389	$3529	$3979
SVGA/Color	$3319	$3499	$3639	$4089

Turn the page for Portables & Peripherals

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Portables with More Power than Desktops.

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VGA Gas Plasmas *from* ______ **$2595**

"THE VGA PORTABLE III IS EXTREMELY FLEXIBLE... ...more [disc] drive capacity than most portables...and the bang-for-the-buck ratio is very high, excellent high powered performance."

-PC Magazine : Over 20 pounds, over 20Mhz portables December 12, 1989

512K (286) or 1024K (386) RAM
Serial, Parallel, and Game Ports
1.2MB or 1.44MB Floppy, 86-Keyboard

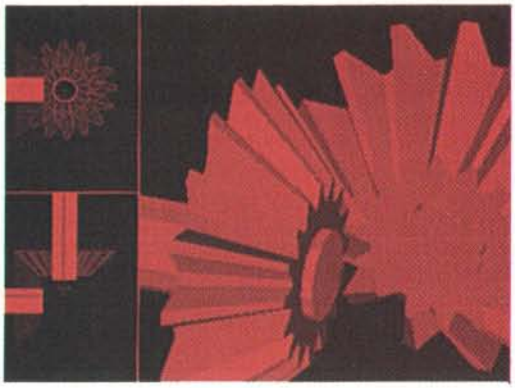
The power, reliability and performance of our desktop system motherboards combine with our portable casing to make our systems technically unique!

We support 3 built-in, externally accessible disk drives, enabling dual (3.5" and 5.25") floppys for *total* media compatibility. Including tape CD-ROM drives or other devices to deliver desktop functionality in a Portable Unit.

Simultaneous internal AND external monitor support, VGA functionality, 2open card slots and our unique 3 drive support, permit this family to be used as a complete *"in the office system"* which you can pick up and take anywhere.

Standard System Features:

- All performance and compatibility features as in desktop models featured on previous pages
- 3 Accessible Drive Bays for 2 5.25" & 1 3.5" Units
- 2 Available Peripheral Card Slots
- 16 Grey Scale 640x480 VGA Plasma or 4 Grey Scale 640x400 CGA/Mono Graphics Backlit Supertwist LCD Display
- Simultaneous internal and external displays
- 200Watt Auto Voltage Switching Power Supply



Actual VGA PLASMA Screen Image 16 grey scale display operates concurrently in all VGA modes with external monitor

VGA Gas Plasma Portables

Drives	286/12	286/20	386/SX-16	386/20	386/25
1 Floppy	$2595	$2795	$2895	$3350	$3550
40MB-25MS	$2995	$3195	$3295	$3750	$3950
66MB-25MS	$3095	$3295	$3395	$3850	$4050
100MB-25MS	$3395	$3595	$3695	$4150	$4350
200MB-19MS	$3960	$4160	$4260	$4710	$4910

LCD Backlit Portables

Drives	286/12	286/20	386/SX-16	386/20	386/25
1 Floppy	$1745	$1945	$2045	$2495	$2695
40MB-25MS	$2145	$2345	$2445	$2895	$3095
66MB-25MS	$2245	$2445	$2545	$2995	$3195
100MB-25MS	$2545	$2745	$2845	$3295	$3495
200MB-19MS	$3110	$3310	$3410	$3855	$4055

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Monitors*

Magnavox

CM8762 13" RGB Color (640x200)	$230

Mitsubishi

1381 14" Diamond Scan VGA/EGA (to 800x600)	$499
HL6605 16" VGA/EGA (to 1280x1024)	1295
HL6905 20" VGA/EGA (to 1280x1024)	2325

NEC

MultiSync GS-2A 14" Multi Mono (to 800x600)	$249
MultiSync 2A 14" VGA (to 800x600)	479
MultiSync 3D 14" VGA/EGA (to 1024x768i)	649
MultiSync 4D 16" VGA/EGA (to 1024x768)	1150
MultiSync 5D 20" VGA/EGA (to 1289x1024)	2350

Panasonic

C1391 PanaSync 14" VGA/EGA (to 800x600)	$489
M1500 15" Mono (1280x960)	559
M1900 19" Mono (1280x960)	849

Princeton Graphics

Max 15 14" Multifreq. Mono (to 1024x768i)	$249
UltraSync 14 14" VGA/EGA (to 800x600)	520
UltraSync 16 16" VGA/EGA (to 1024x768i)	879

Princeton Publishing Labs

Multiview 15" Full Page w/adaptor (800x1000)	$890

Relisys *(Top Rated by Infoworld and PC World)*

9503 14" VGA Mono (640x480)	$135
9513 14" VGA (640x480)	369
1520 15" VGA/EGA Multifreq (to 1024x768)	679

Seiko NEW!

1440 14" VGA	$599
1450 14" VGA	$779

Sony

1304 14" VGA (to 1024x768)	$689

Zenith

ZCM-1492 14" Flatscreen VGA (640x480)	$619

Disk Drives

360K 5.25" Half Height Black	$75
720K 3.5" HH Black w/5.25" Mounting	80
1.2MB 5.25" Half Height Grey	85
1.44MB 3.5" HH Grey w/5.25" Mounting	95

PS/2 Floppy Drives

CMS 5.25" 360K-PS/2 Ext.Floppy	$199

Iomega

B120I Single 5.25" 20MB Int. w/o Interface	$765
B144I Single 5.25" 44MB Int w/o Interface	995
B244X Dual 5.25" 44MB Ext w/o Interface	1995
PC2/50 Nonbootable Interface	230
PC2 B/50 Bootable Interface	230

Hard Disk Drives:

Connor

100MB 25ms IDE (3.5" in 5.25")	$679
200MB 19ms IDE (3.5" in 5.25")	1249

Micropolis

330MB 18ms 1558-15 ESDI Full Height	$1550
640MB 18ms 15 Mbit ESDI Full Height	2695

Seagate

20MB 65ms ST225	$209
20MB 35ms ST125	$245
30MB 35ms ST138	310
40MB 28ms ST251-1 MFM	349
40MB 24ms ST151	419
44MB 25ms ST157 IDE	399
80MB 28ms ST4096 Full Hgt. MFM	590

Add $50 for XT Kit for ST1xx, ST2xx

Toshiba

66MB 25MS MK134 RLL (3.5" in 5.25")	$429
110MB 25MS MK72 RLL Full Height	669

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40/80MB Colorado Memory-Internal QIC-40	$249
60MB Archive Int. or Ext. w/Cntrl.	590
60MB Maynard Maynstream Portable	889
150MB Archive Internal/External	925/1250
150MB Maynard Maynstream Portable	1395
2.2GB Maynard Maynstream Portable	4350

Modems

ATI

2400ETC Internal Modem w/MNP5	$165
2400ETC External Modem w/ MNP5	205

Hayes

1200B Int. w/Smartcom	$189
2400B Int. w/Smartcom	249
1200 Ext.	Call
2400 Ext.	Call

PC Brand *100% Hayes Compatible!*

1200 Internal (w/Bitcom Software)	**$49**
1200 External	**70**
2400 Internal (w/Bitcom Software)	**89**
2400 Extenal	**129**
2400 Internal w/MNP5	**129**

US Robotics

Courier HST 14,400	$599
Courier V.32 9600 External	889
Courier HST/V.32 Dual Standard Modem	995
Courier 300-9600 Inter nal	579

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Brother

HL-8e Laser (LJ-II, HPGL) Editor's Choice	$1875
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Canon

BJ130e Wide Cartridge, 360dpi, QUIET!	$769
LBP4/LBP8-III Laser Printers w/Fonts	1025/1725

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Color Kit	$49

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LQ510 180/60 CPS	$329
FX850 330/88 CPS	345
FX1050 264/54 CPS	445
LQ850 330/88 CPS.	509
LQ1050 330/88 CPS	695
LQ950 264/88 CPS	509
LQ2550 400/108 CPS	945
LQ1010 (New)	Call

Kodak Diconix

150Plus 150/50 CPS	$315
300WP 310/73 CPS	$439

Hewlett Packard

Deskjet Plus.	$710
Laserjet II.	$1720
Laserjet IIP	1025
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PDP Plotter in Cartridge	$249
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CPI 1MB Memory Kit	269
CPI 2MB MemoryKit	549

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PS-388 Postscript Emulation RISC board	$2250

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P2200XE 192/54 CPS	$335
P9XL 400/140 CPS	$1030
LC890 Postscript	3190
LC890XL Laser	4495

Okidata

ML320 300/62 CPS	$345
ML321 300/62 CPS	$479
ML380 180/60 CPS..	359
ML390 270/90 CPS	475
ML391 270/90 CPS	655
ML393 450/120 CPS	995

Panasonic

1180 192/38 CPS	$189
1191 240/48 CPS	$245
1124 192/63 CPS	299
1624 192/63 CPS	429

Video Cards

ATI

VGA Wonder w/256K/512K (16 bit)	$279/349

Cardinal

VGA 100 (8 bit) to 800 to 600	$99

NEC

Graphics Engine 512K	$999
Graphics Engine 1M	$1349

Paradise

EGA Autoswitch 480 W/256K (SEGA 640x980)	$139
VGA+ w/256K (8 bit) to 800x600	219
VGA+ w/256K (16 Bit) to 800x600	249
VGA 1024 w/512K (to 1024x768i)	239
8514/A	Call
8514/A w/VGA	Call

PC Brand

EGA Autoswitch w/256K (8 bit)	**$99**
VGA w/256K (16 bit) (Paradise compatible)	**139**

Video Seven

1024i VGA w/256K (16 bit) (to 1024x768i)	$259
VRAM VGA w/512K (16 bit) (to 1024x768)	495

Networking

Novell

4 User ELS 286 Level 1	$429
8 User ELS Level II (Version 2.15)	939
Advanced Netware 286 (Ver. 2.15)	1850
SFT Netware 286 (Ver. 2.15)	2850
Netware 386 (free upgrade to 3.1)	4550
Lantastic - Easy to Install Network	Call

Standard Micro

PC130 Arcnet Board	$135
PC270E Twisted Pair Arcnet Card	139
PC500-WS 16 Bit Work StationBoard	375
PC500-FS 16 Bit File Server Board	449
PC550-WS 16 Bit Twisted Pair Work Station Bd	395
PC550-FS 16 Bit Twisted Pair File Server Bd	495
PS110 Arcnet Board for PS/2	439
ARCNET passive/ Active Hubs	72/359

Tiara

4 Port/8 Port Hubs	$49/285
Lancard/A 8 Bit ARCNET Board	89
Lancard/E 8 Bit ETHERNET Board	199
Lancard/E 8 Bit Twisted Pair ETHERNET	329

Western Digital

Ethercard+ w/Novell Drivers	$219
Ethercard+ A for PS/2	320
Ethercard+ Twisted Pair Ethernet Board	319

Software

Aldus Pagemaker.	$499
AMI Word Processor for Windows	129
Ashton-Tate DBASE IV	449
Borland Quattro	95
Borland Quattro Pro	Call
Central Point PC Tools 5.5	79
Lotus 123 r. 2.2 or 3.0	339
Microsoft Excel 2.1	309
Microsoft Windows 386	125
Microsoft Word 5.0	205
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Quarterdeck Desqview 386	115
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Circle 313 on Reader Service Card

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The truth is, for most 3270 PC-to-mainframe applications, performance DOES matter.

When you're linking multiple PCs — a few, a dozen, or hundreds — to your IBM mainframe, it just makes sense to do it with the highest speed and efficiency available. Often, a simple plug-and-play product isn't enough.

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We deliver DataTalker 3270 on a powerful co-processor board with on-board memory. This allows you to offload all communications processing from your gateway PC, freeing it for applications processing.

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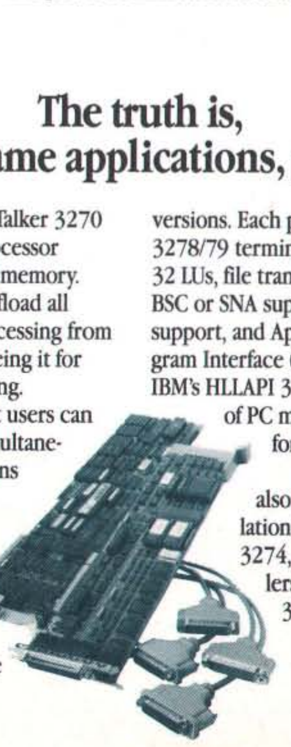
We offer DataTalker 3270 in both DOS- and UNIX-compatible versions. Each provides full IBM 3278/79 terminal emulation, 32 LUs, file transfer (IND$FILE), BSC or SNA support, NetView support, and Application Program Interface (our own plus IBM's HLLAPI 3.0). Only 1K of PC memory is required for API applications.

DataTalker 3270 also provides full emulation of IBM 3174, 3274, and 3276 controllers, as well as IBM 3287 printers.



Only 1K of memory require
for API applications.

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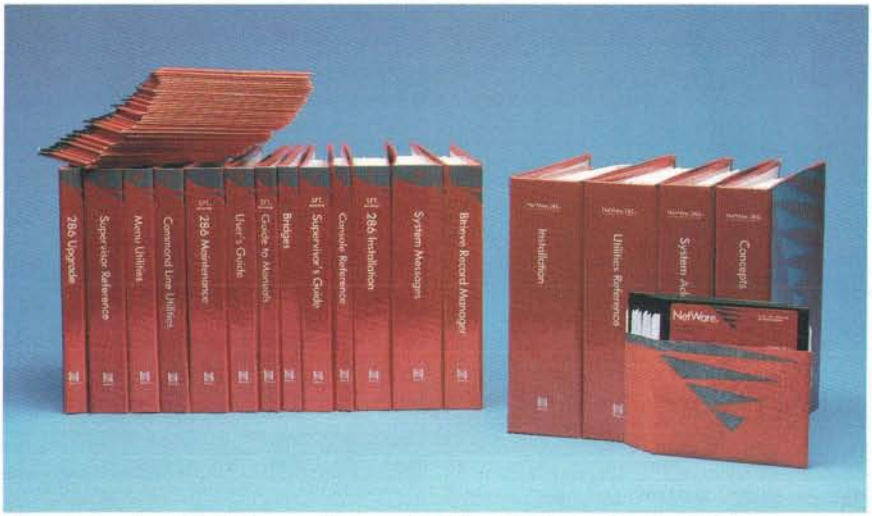
NetWare 386: Less Pain, Great Gain

Novell's next-generation LAN operating system is ready for prime time

Jon Udell



The most noticeable difference between NetWare 2.15 and NetWare 386 is the size of the packages: 45 floppy disks and 13 manuals for NetWare 2.15 versus nine floppy disks and four manuals for NetWare 386.

No more Netgen! Novell's new NetWare 386 version 3.0 does away with the much-hated installation and configuration program that drove countless NetWare 286 customers into the arms of value-added resellers. A colleague and fellow Netgen sufferer watched with me as NetWare 386 made good on its claim: It transformed an 80386 PC into a NetWare server in 20 minutes. It delivers compatibility with its 80286 cousin, radically improved performance and capacity, and new and enhanced utilities. NetWare 386 is a sophisticated, open operating system that will compete with Unix and OS/2 for the hearts and minds of software developers. Unfortunately, there's no upgrade program for NetWare 2.1x users. Even if you've already spent $4995 for NetWare 2.15 with all the trimmings, you'll still have to fork over a full $7995 for the 80386 product.

NetWare 386 holds to the design goals of its predecessors. Unlike DOS, OS/2, Unix, and the Mac OS, which are all general-purpose operating systems that have been adapted for use as file servers, NetWare has always been a specialist—a pure file server engineered for maximal I/O performance. To that end, NetWare 2.15 runs in 80286 protected mode, multitasks cooperatively rather than preemptively, and uses a proprietary, server-adapted file system. NetWare 386 fits that description, too, but it requires an 80386 or i486 processor. It runs these processors in its native 32-bit mode and breaks new ground in several critical areas.

NetWare 2.15 topped out at 100 connections (concurrent users), 1000 open files, and 32 gigabytes of disk storage. NetWare 386 boosts those numbers to 250 connections, 100,000 open files, and 32 terabytes of storage. The number of volumes per server (32) stays the same, but with NetWare 386, a volume can span multiple disks. So storage can grow by convenient increments to vast proportions. That's a scenario that should make a prospective minicomputer buyer stop and think.

Of course, performance and storage capacity aren't the whole story. Buyers who favor minicomputers over PC LANs do so because minicomputer operating systems, such as Unix and VMS, intrinsically support the client/server application model that LANs are now struggling to emulate. NetWare value-added processes, the foundation of server-resident utilities like Btrieve and NetWare for the Macintosh, added invaluable capabilities to previous versions of NetWare and were a step in the right direction. But VAPs never lived up to their full potential. Writing a VAP required an intimate knowledge of NetWare internals and VAP-specific development techniques that third-party programmers found difficult to assimilate.

NetWare 386 loadable modules are the new VAPs. NLMs borrow two great ideas from OS/2: They link dynamically to the kernel and can execute as multiple threads. By providing NetWare-specific ANSI C- and POSIX-compatible libraries, a convenient development and testing environment, and extensive application programmer interface documentation, Novell has flung open the gate to third-party developers. Given Novell's commanding market position, it's likely that the company will charge through and create a significant base of server applications.

Novell will have to compete for those

continued

developers, however. OS/2 LAN Manager makes OS/2 a potent environment for building distributed applications, particularly in view of the new OS/2 1.2 High Performance File System, the just-announced 80386-specific version of HPFS for LAN Manager 2.0, and the imminent, full-blown 32-bit OS/2. And while OS/2, like NetWare 386, still lacks maturity and a strong base of applications, LAN Manager/X, Microsoft's OEM-only version of LAN Manager for Unix systems, will link established Unix applications to DOS and OS/2 clients and offer yet another attractive development platform. NetWare's new open architecture comes not a moment too soon for Novell.

An Architecture for the 1990s

NetWare 386 arrived on nine 1.2-megabyte floppy disks and came with four manuals. That was a welcome relief: 2.15 comes on 45 360K-byte floppy disks with a shelf of documentation so formidable that Novell felt compelled to supply a separate book entitled "Guide to Manuals" (see photo). I installed the software on a 4-megabyte Fortron 386/33 with a 140-megabyte hard disk drive. (The minimum requirement for NetWare 386 is 2 megabytes of RAM.) The choice of LAN adapters is limited, initially, to Novell's own Ethernet and ARCnet and IBM's Token Ring boards. I used an NE2000 and connected it to Synoptics Lattisnet (twisted-pair Ethernet) cabling by way of an external transceiver.

Installation was a snap. I didn't even crack open the manuals; the "Quick Path" cheat sheet covered everything I needed to know. Although it is amazingly simple, the installation procedure tells you a lot about how NetWare 386 works. To begin, you set up a small bootable DOS partition. Why boot DOS? One reason is that the NetWare kernel, SERVER.EXE, is a DOS-executable program that accepts command-line arguments. For example, the `server -C8KB` command instructs the kernel to use 8K-byte cache buffers rather than the default 4K-byte buffers.

More generally, the DOS partition is where NLM developers will ply their trade. You write source code and run the NetWare compiler and linker in the DOS partition and then fire up the NetWare kernel and `load` the resulting NLM to test and debug it. (The compiler is a version of the Watcom C 386 compiler [see "Power to the Programmer," December 1989 BYTE].) Another new NetWare console command, `exit`, returns you to DOS to continue programming.

Next, you copy the operating system and the support NLMs to drive C, create a simple AUTOEXEC.BAT that calls SERVER.EXE, and boot the server. The NetWare console prompt (a colon) comes up instantly. At this point, a NetWare 2.1x veteran's eyebrows shoot up. NetWare 286, like Unix, uses a conventional linker to attach drivers to the kernel. That makes installing the 286 product a tedious exercise and necessitates downtime whenever you reconfigure the system. NetWare 386 loads drivers on the fly and, equally important, can also unload them.

The NLMs come in four flavors: disk drivers (.DSK files), LAN drivers (.LANs), name-space support modules (.NAMs), and general-purpose loadable modules (.NLMs). The console command `:load isadisk.dsk` configures the system for a standard AT-type controller, and the `:load ne2000.lan` command sets up the NE2000 Ethernet adapter. The command `:load mac.nam` prepares the server to store Macintosh files. The NLMs that replace the Macintosh VAPs haven't been released yet, but Mac users can connect to an 80386 server on a multiserver network that includes a NetWare 2.15 server running NetWare for Macintosh's AppleShare emulation (version 1.1 is required). The loadable name-space support is a nifty invention. For example, Novell might offer an HPFS name space to support OS/2 1.2 clients; however, there's a price. Each name space requires an extra directory entry for every file, and server RAM in which to cache those directory entries.

The DOS partition is where NLM developers will ply their trade.

The next step in installation is to literally bind a transport protocol to the LAN driver: `bind ipx to ne2000`, in my case. Novell's new "Open Data-Link Interface" is a strategic standard designed to free NetWare from dependence on its native IPX/SPX transport protocol. Any protocol written to the ODI will run on any LAN adapter whose driver conforms to the ODI. Moreover, under ODI, multiple protocol stacks can share a single LAN adapter. The company plans to write ODI-compliant AppleTalk (Macintosh), NetBEUI (OS/2), and TCP/IP (Unix) protocols.

Just as ODI isolates protocols from underlying hardware, another new Novell standard, modeled on a Unix facility called Streams, isolates service protocols from transport protocols. NetWare Core Protocol is the native protocol that clients use to access NetWare's file and print services. By the means of NLMs, Novell is planning to extend support to the AppleTalk Filing Protocol, IBM's Server Message Block, and Sun's Network File System. What does all this add up to? NetWare 386 is, in principle, a universal file server. Although DOS clients are the primary focus, for now OS/2, Unix, and Macintosh clients can share the powerful engine that is a NetWare 386 server. And they'll do so quite naturally, in terms of their native transport and service protocols.

Up and Running by Lunchtime

Once you've bound IPX to the LAN driver, you load the `install` NLM. With it, you create disk partitions, mirror drives, create and mount volumes, copy system and utility files to the server, and create two start-up files called STARTUP.NCF and AUTOEXEC.NCF. The STARTUP.NCF file lives on your DOS boot device—either a floppy disk drive or drive C partition. It loads disk support so the server can access AUTOEXEC.NCF on the more secure NetWare SYS: volume, which in turn loads everything else.

NetWare 386 runs each console task in its own screen group à la OS/2. It's a nice convenience. For example, while running `install`, a full-screen menu-driven utility, I needed to get at the console command line to mount the volume I'd created. No problem: You press Alt-Esc to cycle from screen to screen. Another nice touch is the command-line recall at the console.

All this takes longer to describe than to accomplish. In remarkably short order, I added a NetWare 386 server to an existing NetWare 2.15 network. I then immediately discovered that NetWare 386 doesn't handle multiserver administration any differently than 2.1x. There's no concept of a "domain" or "global name space" distributed throughout a network. Each server has its own supervisor, user accounts, and public utilities.

continued

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In the long run, for example, a high-speed modem can save you a small fortune on phone bills. More data sent in less time means less money to the phone company.

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Resending data costs both time and money. The less time you spend transmitting data, the more time you have to spend on your business.

Downtime and adaptation time can also cost you dearly.

Be sure to ask if the modems are compatible with their earlier generations. You don't want to start with suppliers who regularly obsolete their own products, or who don't offer you an upgrade path.

Modem support can be a real hassle with the wrong vendor.

Setting up and installing your modem can affect both your budget and your sanity. Many manufacturers forget to make their modems easy to use!

This becomes expensive when you want to start up fast or need to support a large number of users.

Dip switches, on-line help screens, and easy-to-use manuals should be demanded. It also helps to have a quick-reference guide printed on the bottom of the case.

In sticky situations, it's vital to have toll-free support and applications engineering.

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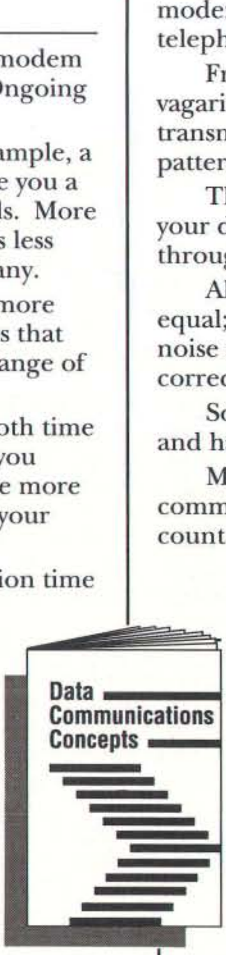

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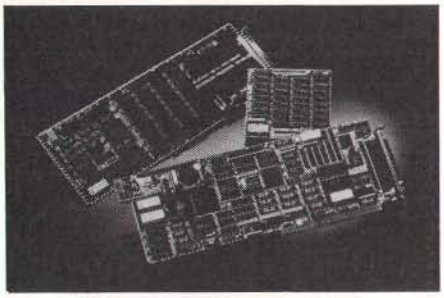

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Documentation
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Novell should fix this problem. Microsoft's announcement that LAN Manager 2.0 will support domain management may encourage Novell to follow suit.

Is NetWare 386 twice as fast as 2.15, as Novell claims? Yes, depending on how you define your terms. Here's one way to look at it. The 2.15 server was a 10-MHz 80286-based NEC PowerMate IV with 4 megabytes of extended memory and a 16-bit MICOM Interlan adapter. The NetWare 386 server was a 33-MHz 80386-based Fortron that had 4 megabytes of extended memory and a 16-bit NE2000 adapter. I used the BYTE File I/O benchmark (see "Battle of the Network Stars," July 1989 BYTE), which opens multiple files and performs seeks, reads, and writes in a pattern designed to simulate a typical database application. Under these conditions—each server operating system running on the class of hardware for which it was designed and with access to equal (and ample) quantities of cache RAM—the NetWare 386 server ran the File I/O test in half the time of the 2.15 server.

On a more disk-intensive test—a 20-megabyte XCOPY from each server to a workstation—the NetWare 386 server again outperformed the 2.15 server, but not so dramatically. The NetWare 386 server did the XCOPY in three-quarters of the time of the 2.15 server. This test, which clearly overwhelmed both servers' caches, shows the leveling influence of the standard AT-style I/O bus common to the two machines. If you add 32-bit Extended Industry Standard Architecture or Micro Channel architecture disk drive controllers and LAN drivers to the setup, it's a good bet that NetWare 386 will put them to work. When you have a huge multidisk volume hooked up to your server by way of a disk coprocessor board, the DCB driver will be able to use those disks in parallel by taking advantage of the SCSI disconnect feature.

The Old and the New

NetWare 386 introduces a handful of welcome new features. The print server, which was integral to the 2.1x kernel, emerges as a separate NLM. This means that you don't have to shut down the server and run Netgen to add or reconfigure a printer. Instead, you unload the PSERVER module, update the printer database with PCONSOLE (the NetWare utility that controls printers and queues), and then reload PSERVER.

The printing services are much improved, too. You can associate a "notify list" with each printer so that the print server can route status messages (e.g., "printer offline" or "printer out of paper") to one or more users. Even better, PCONSOLE extends direct control over printers to individual workstations. Users can check the printer's status and pause, restart, or abort a job. The long walk to the laser printer won't become a thing of the past, but you won't need to do it nearly so often.

Administrators will appreciate the new DSPACE utility, which restricts the amount of hard disk space users or directories can consume. For example, you could put a 10-megabyte cap on all user accounts; that limits the total space permitted for all the files owned by each user. At the same time, you might restrict each user's private backup directory to, say, 2 megabytes. NetWare 2.1x had the former capability; NetWare 386 adds the latter. With CHKDIR, another new tool, users can view the restrictions in effect for volumes and directories.

In NetWare 2.1x, access rights (e.g., trustee assignments) apply to directories. NetWare 386 extends rights to individual files. The 2.1x SALVAGE utility, which recovers deleted files, remembers only the most recently deleted file. NetWare 386's SALVAGE retains information about those files as long as possible—that is, until you purge them or the server runs out of disk-allocation blocks. A salvaged file reappears in the directory from which it was deleted, unless the directory itself is gone. In that case, NetWare 386 restores the file to a hidden directory called DELETED.SAV. If you have accidentally deleted a whole directory tree, you'll lose its structure, but at

continued

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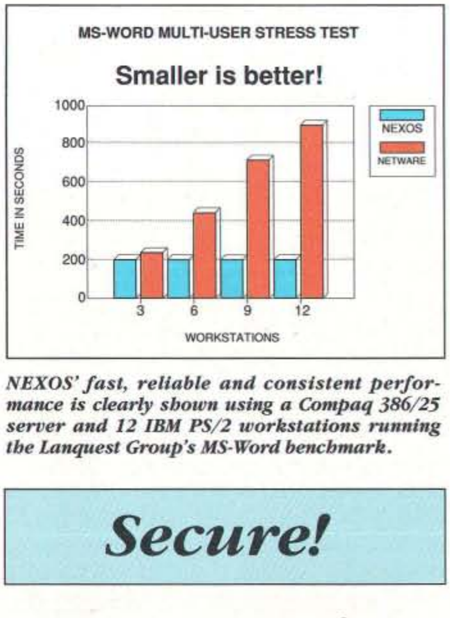

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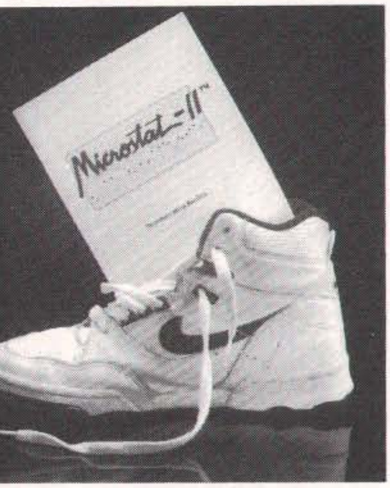

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least you'll be able to recover the files. To do that, the new FILER utility comes in handy. FILER has gained the point-and-shoot directory navigation capability that its predecessor lacked.

If you add a NetWare 386 server to a 2.1x network, you can copy the NetWare 386 workstation utilities to the 2.1x server's Public directory. If you take advantage of NetWare 386's new password encryption, you'll have to transfer the utilities; otherwise, the 2.1x server will be locked out. Utilities that are compatible with the older file system, such as FILER, work just fine and deliver some new features. Ones that aren't, such as DSPACE, will politely refuse to work on the 2.1x server.

One of NetWare 386's handiest features operates behind the scenes: The server dynamically configures itself to adapt to changing loads. With 2.1x, some tuning is possible. You can, for example, specify the number of directory entries that a volume can support. That, in turn, governs the amount of RAM required to cache the volume's directories. To change this configuration you must—you guessed it—shut down the server and run Netgen. NetWare 386 dynamically allocates memory for file and directory caching, and also for things like packet buffers, record locks, transaction tracking system activity, and NLMs. The server tunes itself. In fact, Novell advises reviewers to run benchmarks several times to give the server a chance to adapt to the task at hand. I tried that and found that on the second pass the File I/O test did indeed run marginally faster on the 386 server (but it ran just the same on the 286 server).

Unanswered Questions

Should you upgrade? If your organization uses NetWare 2.15, you'll want NetWare 386. Even if you're not pushing 2.15's performance envelope, NetWare 386 eliminates several maintenance headaches and is a passport to the world of distributed applications that's finally ready to open up. Unfortunately, you can't get there from here. The 2.1x server is a dead end. You'll have to write off your investment in it and start over with NetWare 386. That's a shame. The loyal customers who've given Novell the lion's share of the PC LAN market deserve a break. Big companies may not feel the bite, but a lot of small- to medium-size operations are going to be left out in the cold.

Will developers support NetWare 386? In view of that lion's share, the answer is undoubtedly yes. There is, however, a spirited debate in the developer community concerning the new NLM architecture. NLMs multitask cooperatively and run at the 80386's highest privilege level, in the same address space as the kernel. Because an NLM can't be preempted, an NLM could refuse to relinquish control and hang the server. Of course, applications running under MultiFinder on the Mac are in the same boat, and yet, order generally prevails—thanks to a strong educational effort on Apple's part. The more serious objection relates to Novell's utter rejection of Intel's segmented architecture. The 80386 processor devotes a lot of silicon to the support of memory protection. The 80386 implementations of Unix use that protection to isolate processes from one another. The 80386-specific OS/2 will do the same.

But memory protection requires segmentation, which Novell religiously opposes on the grounds that it's too costly in terms of performance. So there's nothing to stop a rogue NLM from taking out the kernel—and with it, your multigigabyte disk farm. Novell's response is twofold. First, the company likes to point out that Unix and OS/2 can't be made bulletproof either: They depend on drivers that require unrestricted access to hardware. Second, Novell plans to run an NLM certification program. The company will test third-party NLMs, and, presumably, you can buy Novell-certified NLMs with confidence. Novell's own NLMs—including the INSTALL, MONITOR, PSERVER, and VREPAIR utilities shipped with NetWare 386—are clearly functional and solid.

It's really a cultural issue. Developers who like working with DOS will probably love the radical freedom NetWare 386 gives them. Those who prefer OS/2 or Unix should expect headaches. Either way, developers are bound to aim for the NetWare market and will undoubtedly create (and port) many useful server-based applications, and that's the name of the game. First-generation PC LANs were pale imitations of the minicomputers they sought to replace. The next generation has now arrived. NetWare 386 isn't the whole story—both OS/2 and Unix are making strong bids as server platforms—but it is a very important chapter. The drama that plays out over the next year or so will be fascinating to watch. ■

Jon Udell is a BYTE senior technical editor at large. You can reach him on BIX as "judell."

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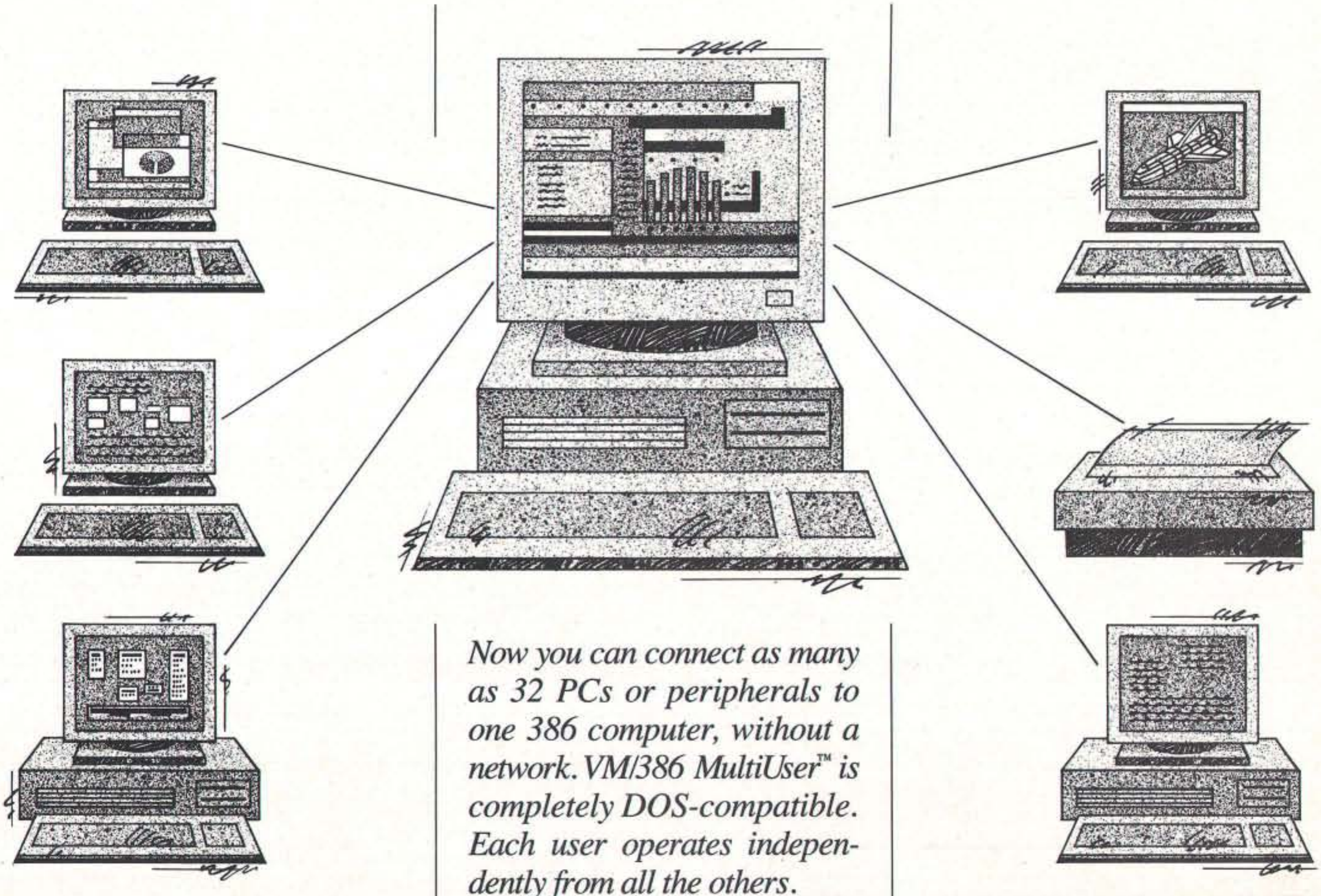

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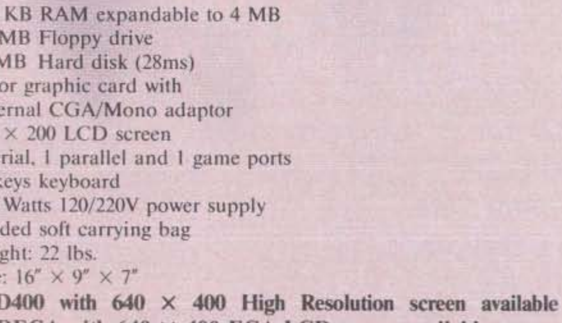

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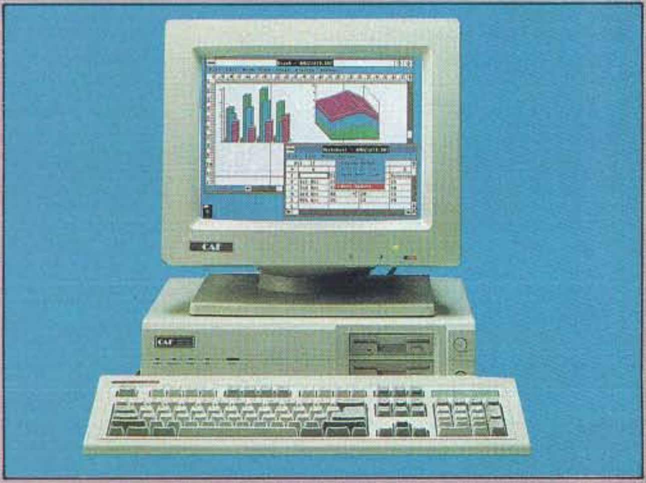

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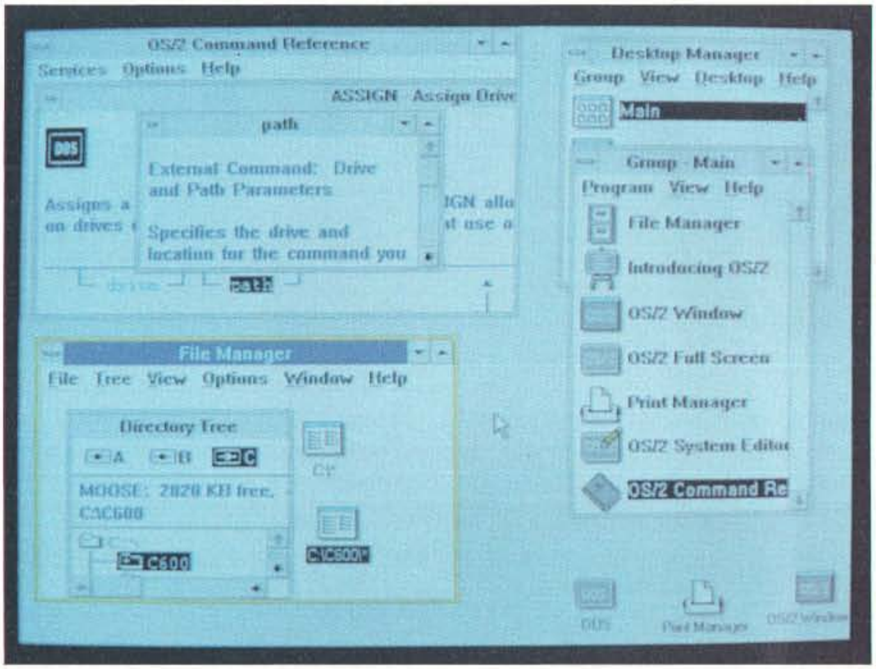
OS/2 1.2: A Zaftig System

Slick three-dimensional looks, a hypertext help system, and a faster file system raise OS/2 to new heights

Martin Heller



External Command: Drive and Path Parameters

Specifies the drive and location for the command you

MOOSE: 2820 KB free.
C:\C600

A bird's-eye view of some new OS/2 features: The three-dimensional look (notice how the scroll bar's arrow buttons stand out), hypertext help facility, and Desktop Manager.

Zaftig, for anyone not familiar with the word, is Yiddish for "pleasantly plump." And that is exactly how I describe OS/2 1.2; it's pretty, but it needs to go on a diet.

OS/2 has always featured preemptive multitasking, protected-mode operation, multiple threads of execution, and a rich application programmer interface (API). OS/2 1.0 operated in character mode, and OS/2 1.1 added a graphical user interface, the Presentation Manager (PM).

OS/2 1.2 brings even more. There's a new High Performance File System (HPFS) and a hypertext-based help system called the Information Presentation Facility (IPF). The PM has been enhanced with the addition of new File, Desktop, and Print Managers. OS/2 1.2 adds polish to the PM's appearance and to the System Editor. It also improves the DOS compatibility mode and adds some device drivers. Finally, certain system limits have been removed, and a file-typing facility called Extended Attributes has been added.

Installation

I installed IBM OS/2 1.2 on an ALR FlexCache 20386 with 6 megabytes of RAM, two ESDI hard disk drives—one 150 megabytes and the other 300 megabytes—and a Video Seven VRAM VGA card. I had DOS 3.3 and OS/2 1.1 installed previously, and I used Microsoft's dual-boot utility to choose one or the other at boot time.

Half an hour and seven disks later, I had a working OS/2 system. Just for the sake of science, I tried the new dual-boot utility. Instead of letting you choose OS/2 or DOS from a menu at boot time, the 1.2 dual-boot utility actually swaps the boot block and CONFIG.SYS and AUTOEXEC.BAT files on your hard disk with the saved files from the "other" system. This allows the machine to boot unattended and still lets you switch systems at will. Switching from OS/2 to DOS worked perfectly, but switching back to OS/2 was strangely unreliable. I reinstalled OS/2 1.2 twice, but to no avail. Some experimentation revealed that my DOS disk cache (PC-Kwik) was giving the OS/2 boot utility fits. I wrote a little batch file to disable my disk cache before invoking the dual-boot program, and the process worked smoothly and reliably.

At this point, however, I had not installed HPFS. It took another morning's work to do this properly, and a few days of intermittent experimentation with the disk-caching parameters to fine-tune it. For anyone else trying to install both HPFS and dual boot, there are a few things to keep in mind.

Most important, you must make your first partition a file allocation table (FAT) system so that DOS will recognize it. Don't bow to the temptation to install

continued

OS/2 1.2

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Hardware Needed
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Documentation
Installation guide; advanced user's manual; on-line command reference

Price
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Inquiry 889.

the OS/2 system on HPFS—DOS won't be able to boot that way.

To enable HPFS, you must add a line of the form

```
IFS=C:\OS2\HPFS.IFS -C:512
```

to your OS/2 CONFIG.SYS file. IFS stands for Installable File System, and HPFS is presently the only one. IBM expects others to follow, both from IBM and third-party developers. The declaration above sets up HPFS as an installable file system and sets its write-behind cache to 512K bytes. While this may seem excessively large, my experiments proved that IBM's default, 64K bytes, was too small.

You also need to add a line like

```
RUN=C:\OS2\CACHE.EXE
  /LAZY:ON
```

This starts the background process that works the write-behind ("lazy") cache. With these two lines added to CONFIG.SYS, you can reboot and have the HPFS loaded into memory.

If your partitions are not as you want them, you need to use the new FDISKPM utility, which you can start easily from the Utilities group in the Desktop Manager. I consolidated my unused 32-megabyte drive L through drive Q partitions into one large drive L partition so that I could test the performance of HPFS on a large partition.

Finally, you can issue a command like

```
FORMAT L: /FS:HPFS
```

to create the HPFS disk structures on drive L. FORMAT also modifies your IFS command in CONFIG.SYS so that HPFS automatically checks your HPFS volumes for integrity each time that you boot OS/2.

Performance

If that all sounds like a lot of work, well, it is. But it's worth it. HPFS has many advantages over the old FAT file system. For starters, it's much faster: I did a series of benchmarks and found the HPFS was between 30 percent and 400 percent faster than the FAT system on the same hardware. The worst-case performance was for very large files. Here, the cache did not help, but the HPFS still outperformed the FAT. The best performance was for small files: Here the cache algorithms in the HPFS worked wonders. In a test that wrote to and deleted small files, the diagnostics could not even measure an elapsed time—the HPFS cache was smart enough never to write the files out to disk.

My diagnostics show that, with HPFS loaded, I have only 1 megabyte of free memory out of 6 megabytes total. Presumably, I could reduce my cache sizes to reduce the memory requirements. However, until OS/2 goes on a diet, I would expect HPFS to cause memory swapping on a machine with less than 4 megabytes of RAM (or 5 megabytes on a development system), which would make it a net loss.

HPFS also has less wasted space than the FAT system and is much less prone to file fragmentation. It also supports long filenames; you are not limited to horrid "XXXXXXXX.YYY" filenames on the HPFS. You can write files called THE—THIRD—REVISION—OF—MY—OS2—ARTICLE, if you like. In a future release, you'll be able to use names like "The Fourth Revision of the BYTE Review of OS/2 1.2," but embedded spaces and mixed-case filenames are taboo for now. If you use the File Manager, you won't ever have to type such a long name after you create it; you just double-click on the file, or drag the file onto the name or icon of the application that you want.

OS/2 1.2's Graphical User Interface

The OS/2 1.2 File Manager looks more like the Xerox Star than does even the Macintosh. The new catchphrase is "direct action," which is used to describe the ability to treat a visible entity (such as an icon or filename) as an object. You can make these objects interact in predefined ways by manipulating their graphical representations with the mouse.

OS/2 1.2 implements, to good effect, its version of direct action with two mouse buttons, rather than the Mac's one. The left mouse button selects, and the right button acts. You can drag while pressing the left button to extend a selection to include more objects. Once selected, you can drag and drop an object (or group of objects) to any sensible destination: A program icon causes that program to execute with the objects dropped onto it as command-line arguments, and other destinations behave just as intuitively. The mouse pointer changes shape to a forbidding symbol whenever objects are dropped where they don't belong. The Control, Shift, and Alt keys modify the action of the mouse. Discontinuous selection of multiple files is done by pressing the Control key and then selecting with the mouse. To select a range, you press the Shift key. Pressing the Alt key while you are dragging a file performs a move regardless of the destination, while pressing the Control key performs a copy.

All this pointing and dragging is much harder to describe than to use, and it is a great improvement over the File Manager shipped with OS/2 1.1. Mac users might miss the Trashcan, but pressing the Delete key deletes currently selected objects after you confirm the deletion for an incredulous dialog box that asks, "Do you really want to erase those files?"

While it may seem like fluff, the new appearance of 1.2 is something to behold. Through creative use of shading, elements of OS/2's new user interface have a convincing three-dimensional appearance. Buttons, for instance, appear to sink into the background when they are pressed. A similar effect is delivered with more impact in the Open Software Foundation's Motif interface (which is patterned after PM), but the three-dimensional look makes Microsoft Windows look (literally) flat by comparison.

The new File Manager displays a single directory tree and up to 32 directories. You can switch the tree from disk to disk at will, although there is a slight delay as each disk directory tree is read. You can display each directory in a name view or an icon view, or as a split window with file details. You can also sort directories by filename, type, creation date, modification date, or access date. The directory displays can include or exclude files, directories, programs, data, hidden files, read-only files, and archive files. Directories can be zoomed or iconized, and the File Manager can arrange

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the directory and tree windows in tile or cascade style. You can view multiple directory windows simultaneously and carry out actions on any visible file or directory.

Overall, I judge the File Manager design, finally, to be worth using. In the inevitable comparison with the Macintosh Finder, OS/2 1.2's File Manager acquits itself honorably, whereas Finder simply left 1.1's File Manager in the dust. And in the comparison with the many graphical and character-mode DOS shells, File Manager comes in near the head of the pack.

The 1.2 on-line help system and tutorial are nice, too. The IPF is particularly well done. Using it, any application can have context-sensitive, hypertext help bound to it and integrated seamlessly with the rest of OS/2's help system. The IPF can do much more than OS/2 on-line help requires of it, and you can expect coming applications to make good use of this new functionality. One of the goals of PM is to make PCs easy to learn and use, and good help and good tutorials go a long way toward this goal. I wouldn't, however, suggest that a novice computer user start with OS/2 on his or her PC.

The DOS compatibility box is not perfect, but it is much better than it has been.

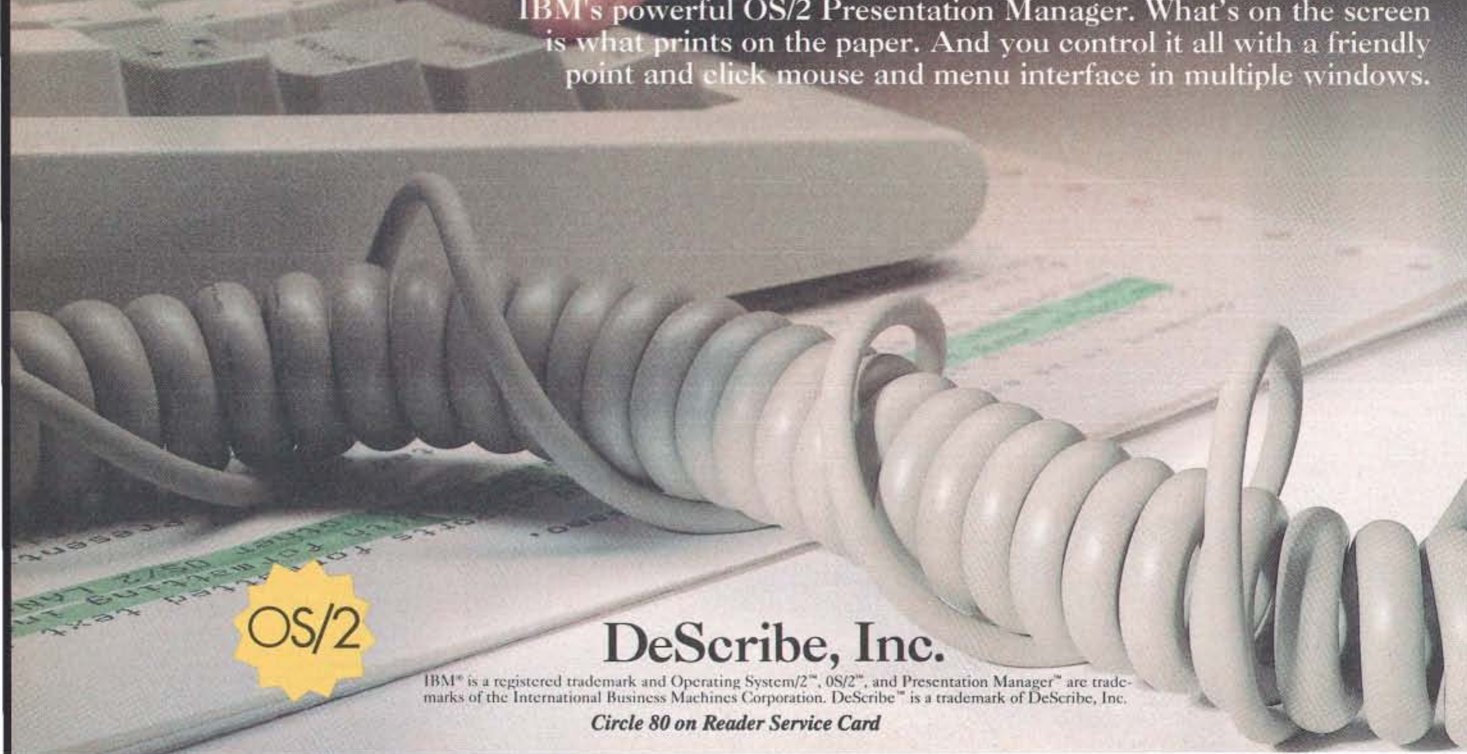
I was pleasantly surprised to find that you can start DOS applications from the File Manager and from desktops. The Managers recognize DOS applications and give them a special DOS icon. The Managers display custom icons for OS/2 applications that have associated icon files. OS/2 programs without special icons get one of two generic OS/2 icons: A sharp-cornered rectangle for programs compatible with the PM, or a rounded rectangle for programs that run in their own screen group.

How good is the DOS compatibility box? Not perfect, but much better than it has been. It doesn't deserve the "penalty box" moniker anymore—most of my DOS programs run fine in OS/2 1.2's DOS compatibility mode. The Norton Utilities are still a no-no, and very big programs (like CAD programs) won't fit into the 520K bytes of RAM that is available. DOS extenders are out. Flight Simulator comes up perfectly, however. Another pleasant surprise is that DOS applications running in OS/2 1.2's DOS mode can use the HPFS. They can even run from an HPFS disk, but they can't see long filenames or extended attributes.

Naming Files: Win Some, Lose Some

Many users have chafed at the limits of DOS's file-naming convention. When your directories fill up with hundreds of files with names like LETT316A.DOC, finding a specific file can become a challenge. And when six different programs use the DOC extension to signify six incompatible formats, chaos can set in rather quickly.

Long filenames solve most of the problem of identifying the data. Extended attributes (EAs) provide the rest



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of the solution. Unfortunately, the implementation of these in OS/2 1.2 is imperfect. Worse, there is little software to support them as yet.

EAs are in hidden files as ASCII text strings. They work on the FAT system as well as on the HPFS, but long filenames work only on the HPFS. If you try to copy a long filename from HPFS to the FAT system, OS/2 gives you an error message and then lets you rename the file. If you use DOS to copy a file that has EAs, the file will copy, but any EAs will be lost. A utility lets you turn EAs into files and vice versa, but it's a nightmare keeping track of EAs that you can't see. I found that the system becomes unbootable when EAs get corrupted.

Promises, Promises

As with all versions of OS/2 to date, part of the story is what *hasn't* shipped. At this writing, the biggest omission is drivers: OS/2 1.2 has two disks carrying maybe a dozen drivers for video displays and printers. No driver for the Hewlett-Packard LaserJet family is included; neither are Super VGA drivers. Screen drivers that worked under 1.1 don't work under 1.2. So much for my 800- by 600-pixel PM screen. [Editor's note: *IBM now has a BBS through which IBM OS/2 users can download new drivers.*]

Support for mixed-case filenames is missing, too. However, it is promised real soon now, along with HP printer support, Extended Edition, the 32-bit OS/2, and the avalanche of "real" applications for OS/2 PM. Some or all of these may be available by the time this article sees print.

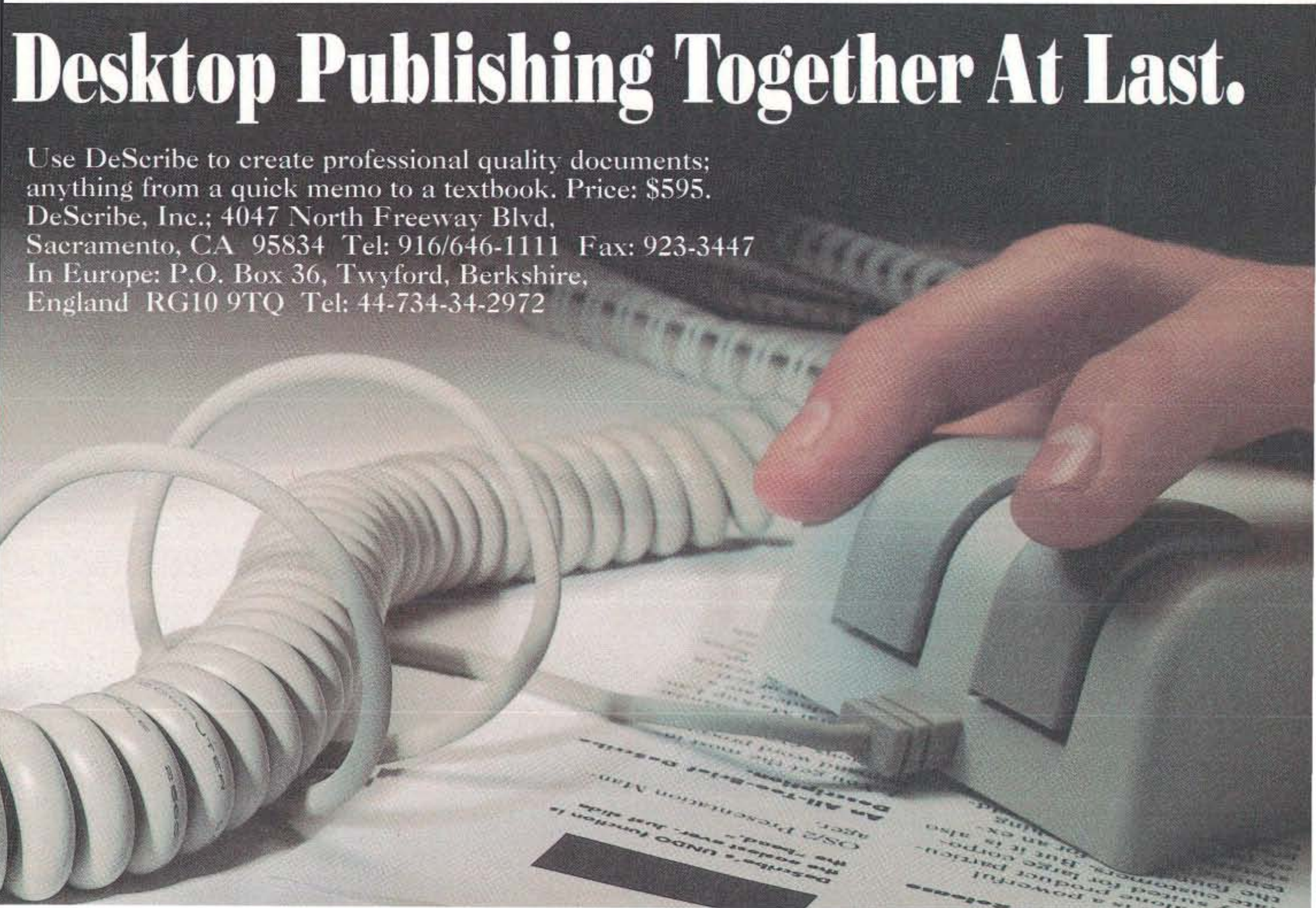
Is It Worth It?

I handle OS/2 support calls in the Boston Computer Society's "Dial Help" program. The question I hear most often is, "Should I adopt OS/2?" Before the advent of version 1.2, the answer was simple: If you're not a developer, it isn't worth it.

Now I'm changing my tune: OS/2 1.2 has enough good stuff and enough worthwhile software waiting in the wings that I'd answer that question with a qualified "Yes." If you've got the resources, now is the time to look into OS/2, even if you don't develop any software. Don't throw away DOS—you'll still need it. If you need a good reason, consider multitasking: Most of the time, while writing this article, I was simultaneously uploading big files to BIX at 9600 bps—with no time-outs. You can't get that kind of performance with DESQview or Windows. At other times, I have gone even further, simultaneously compiling and linking 20,000 lines of C code, downloading my BIX conferences, and editing new code.

If you're a DOS developer, you should consider working under OS/2—even if your target is still DOS. After you've worked with OS/2 a while, you may find yourself wanting to target OS/2. The port from DOS to OS/2 is simpler than you might imagine, and along the way you'll discover bugs that have been lurking in the DOS version for years. OS/2 is still one of the nicest development platforms around. Judging from the improvements in version 1.2, it's going to continue to get better. ■

Martin Heller develops software and writes about technical computer applications. He lives in Andover, Massachusetts. He can be reached on BIX as "mheller."



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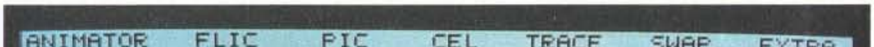
Circle 237 on Reader Service Card (DEALERS: 238)

Art in Motion

Create moving desktop presentations with Autodesk's Animator

Sue Rosenberg



Animator's polymorphic tweening automates the changes from one shape to another.

It's a paint program. It's an animation program. It turns your VGA display into a silent alternative to Saturday morning TV. It's Autodesk's Animator 1.0, a special-effects-filled desktop video program for the IBM PC and compatibles. Combining Animator's image-processing tools with its five types of animation techniques, you can generate complex animations (or *flics*) in very little time and with very little effort.

Animator requires an IBM PC or compatible 80x86-based computer with an 8-MHz or higher clock speed, 640K bytes of RAM, a 10-megabyte hard disk drive, a VGA display, and a Microsoft-compatible mouse or Summagraphics digitizing tablet. The program runs most efficiently on an 80386-based computer.

If you have a spare 2 or 3 megabytes of memory for a RAM disk, Animator can use that space for its workfiles, speeding up some buffer swapping operations and animation playback, but not to any dramatic extent. In one case that I timed, the RAM disk configuration saved 10 seconds of a 150-second color rendering operation. I tested the program on both a 12.5-MHz AT clone with a Paradise VGA board and Logitech mouse and a PS/2 Model 50 with a Microsoft Mouse.

Included in the Animator software are the Animator program to create and display flics and images, and two conversion programs: One for Amiga, Atari ST, Macintosh, and Targa image and animation files, and the other for AutoCAD and similar vector graphics files. There's a public domain animation player that you can distribute freely with your own flics. Also contained in the $299 package are a reference manual, tutorial manual, sample flics and images on disk, and a videotape demonstration to inspire you.

Like a Paint Program, Only Different

Animator has the typical paint program tools—draw, line, box, and circle—that draw freehand lines, straight lines, rectangles, and circles. The circles, however, are not round; Animator uses the 320- by 200-pixel VGA graphics mode, but it doesn't correct for the 8-to-5 aspect ratio. If you want to draw a circle, you can use the oval tool. The word *oval* sounds like a normal, everyday shape, but to Animator, this shape—like some of the program's other shapes (e.g., petal, polygon, regular polygon, shape, spiral, star, and spline curve)—is known as a "tweenable."

Tweenables behave just like ordinary shapes in a single picture or frame, but they spring to life in animation. You draw the starting and ending tweenable shapes, specify the number of frames in the animation, and Animator's *polymorphic tweening* supplies the magic kiss that smoothly transforms a frog into a handsome prince. Or a petal into a star. (I've tried several times to turn a frog into a prince, but my frogs always end up looking like a Matt Groening rabbit.)

Other drawing tools apply color in different patterns. You can choose to paint whole areas of the screen with the selected ink, or you can paint a border

continued

Autodesk Animator 1.0

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(800) 525-2763

Hardware Needed
An 8-MHz or faster IBM 80286- or 80386-based PC with a VGA card and compatible monitor, 640K bytes of RAM, a 10-megabyte hard disk drive, and a Microsoft-compatible mouse or Summagraphics digitizing tablet

Documentation
Reference manual; tutorial manual; quick-start card; videotape (VHS) demonstration

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around an object. The Move tool, independent of ink and brush settings, rearranges an image within the drawing screen. The Separate tool replaces one color with another, or switches a single color with a cluster of colors.

Multiplying the effect of the drawing tools are the ink options. There are 26 ink types. Some apply the active color solidly or translucently and some apply it in a gradient. Others act on the screen colors to blend, increase contrast, darken, lighten, or mix up colors. The Tile option applies the contents of one image buffer in a tile pattern. The Scrape option reveals the contents of another image buffer beneath the current screen.

If you are familiar with other paint programs, you'll find that they are of little help in guiding you through Animator's environment. Unlike most paint programs, you don't see the full set of icons and paints on the screen. In fact, you don't see any icons; almost everything has a name. The closest thing to an icon is a double arrow—like the play button on a VCR—which you click on to play an animation.

Animator's main screen has three sections: A menu bar across the top, the Home panel across the bottom, and the visible portion of drawing area between the two. The menu bar and Home panel hide the rest of the drawing board. You can draw over the Home panel, and what you don't see is what you get. However, you can display the whole screen by clicking the right mouse button on the visible part of the drawing. You can also move any panel up or down by clicking on the panel name and dragging its outline. You can't move the menu bar, and if you try to draw over the bar, you'll pull down a menu instead. You have to display the full screen, hiding the tools and menus, to draw in the menu bar region.

Many things hide in the Home panel. Only six of the 22 drawing tools are visible. Through a series of mouse-clicks, you can select a visible tool, access any of the 16 hidden tools, or get a brief description of the way a tool works. Some tools also have options that control color, shape, and range of effect.

Spilling a Little Ink

Similarly, only six of the 26 ink types appear in the Home panel. You access the ink types panel just as you do the drawing tools panel. Two options that are common to many ink types are ink strength and dithering.

You can access all 256 VGA color registers, but it's not possible to see them all on the Home panel. Four color displays are on the panel: the currently selected color, a seven-color mini-palette, a multicolored cluster used by the gradient inks, and the key color. Screen and buffer areas in the key color are considered to be transparent when one image overlays another. The key color is also an eraser. When the key color button is turned off, the key color is opaque.

Animator can do wondrous things with color, depending on settings and menu choices in the palette panel. It will squeeze up to 21,000 colors into one 256-color palette. It can maintain menus in visible colors when palette colors have been altered. And it will find the best color fit for the existing screen colors when the colors in the existing screen color registers are changed. You can change the color in any register to any of the 262,144 possibilities.

Color cycling is one of Animator's five types of animation. You can select Cycle Draw from the Palette menu to cycle through the current cluster, and then duplicate the drawing over several frames and animate by shifting the cluster colors one register per frame. This type of animation can produce a marquee effect—similar to what's on TV weather maps to show a cold front moving down from Canada.

Although the Brush tool is not exactly hidden, it's not very visible on the Home panel. Initially, it's only 1 pixel large, a mere black dot more likely to be brushed off as a speck of dirt than as an important tool. But you can toggle between 1 pixel and a larger setting of up to 11 pixels. You can't change the shape of the brush; however, tools and inks influence the kind of line that the brush draws.

Even with all its image-processing features, including menu-selectable special effects, you could use Animator only as a paint program. But that would be like using a spreadsheet as an adding machine. People do it, but that doesn't even begin to use the program's capabilities.

The great power of Animator comes from the way it automates actions over time. Typically, you determine a starting point and an endpoint, as with the tweenable shapes, or a path, a motion, a color gradient, or all of these. You determine the length of time, in frames, during which the action occurs, then you let Animator take over the hard part of calculating and rendering all the steps.

In addition to polymorphic tweening and color cycling, Animator performs titling animation, scrolling text in any direction, character by character or pixel by pixel. For "cel" animation, the traditional frame-by-frame drawing, Animator supplies guides to help you position frame-to-frame changes. But the one I like best, which produces the maximum effect for the minimum amount of work, is optical effects. You can rotate a two-dimensional element around the *x*, *y*, or *z* axis, independently or proportionally shrink or enlarge the *x* and *y* dimensions, move on a straight line, move along a path, combine all actions, and apply the combined action to a single cel, a tweenable shape, or even an existing animation.

The Animated Reviewer

After I faithfully completed all the exercises in the tutorial, I felt confident enough to try my own thing. I wasn't going to draw something from scratch—not if I wanted the result to look good. Animator stores a single-frame picture GIF, so I started with a GIF, downloaded from BIX, of a countryside landscape of balloons ready for launch. My plan was to isolate one balloon from the crowd, draw a freehand path to waft the balloon across the sky, shrink the image as it moved higher and higher, and merge the resulting flic with a skyline; at the end, the fading balloon would slip behind one of the skyscrapers.

The first step was to load the picture file and clip out one balloon. The Get

continued

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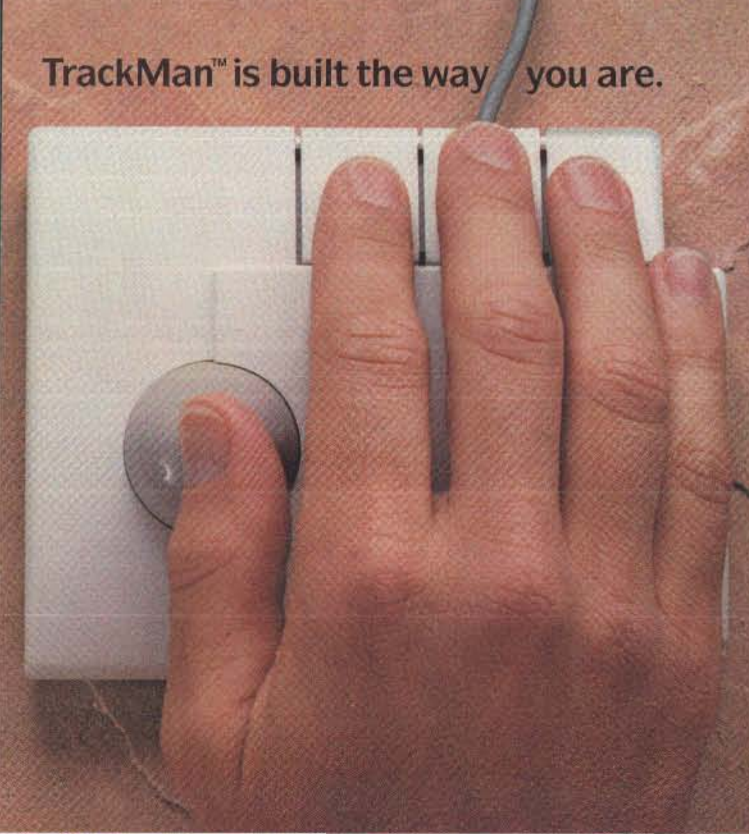

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command clips a rectangle, which meant that I had a lot of erasing to do to isolate the balloon's round shape. Fortunately, there's an easier way to clip nonrectangular images. I used the Polygon tool to outline the image and fill the polygon. I then used the filled polygon to create a mask, and I inverted the mask so that only the polygon area could receive an image. From there, I activated the mask, loaded the image, and clipped the cel. I cleaned up a few ragged edges, but as it turned out, when I prepared the final flic, I didn't even have to do that.

Now that I had a balloon in the cel buffer, I was ready to animate. I decided that 40 frames was about right. From the Optics panel, I selected Path and drew a freehand line that wended left and right and up and away. Then I told Animator to Render the flic. The balloon went up and away, but it didn't get smaller as it went so I chose one of the preset motions and told Animator to pull back the flic. Now as the balloon went up and away, it got smaller and smaller. Its right side also got flatter and flatter, as what had formerly been the edge of the screen was now closer to the middle. This actually was what I wanted, because the balloon could now look like it was disappearing behind the edge of a building. All I needed was the building. I saved the flic and loaded a skyline GIF formatted file, duplicating the image over 40 frames.

Now here's the tricky part. I chose Composite to merge the balloon flic with the resident skyline flic, placing the balloon over the skyline. I told Animator to combine the color maps of both flics, and because each had a limited palette, there was no color changing when the two flics merged. Then I positioned the first balloon frame at what I thought was a good starting place, and that was that. Well, not quite. Instead of disappearing behind the edge of the building, along about the thirty-eighth frame, the balloon disappeared into the front of the building. That's fixable with some other Animator features.

Other than keeping the balloon from banging into the building, there was still some touching up to do. The ragged outline of the balloon made it look as if it didn't belong in the picture. That's where the "soften ink" feature came in. Frame by frame, I drew a line in soften ink around the edge of the balloon and blended the pixels at the border of the balloon with those of the background.

Tweening the Learning Curve

While it was easy to create a composite flic, other actions that should have been simple were difficult to learn. Part of the confusion lies in the inconsistent way that Animator hides and reveals its buffer areas. You can save all sorts of things: a single screen or portion in a cel buffer, one frame in a swap screen, a path, the last tweenable object used, a mask, or text.

A "view" menu selection lets you see the swap-screen buffer, optics path, and mask, but to see what's in the cel buffer, you have to select Move or Paste and then cancel the action. To look at the text, you select Edit from the Text tool or Titling menu and then cancel the edit. To view the tweenable shape, you must select the Polygon tool and then choose Reuse to redraw the shape, and Undo to cancel.

One of the nicer touches in Animator is the Browse Flics screen, where the first frame of each flic appears in miniature. High on my wish list is a Browse Buffers screen, with the contents of each displayed in miniature.

I discovered the hard way that some tool, ink, and command combinations simply don't work together. For example, the Paste command only works when Opaque ink is active, and the Separate menu command doesn't work when the Separate tool is turned on. Of course, Animator knows the rules, but I had to guess at them. I would prefer to have menu choices grayed out if the wrong inks and tools are active, rather than trying to figure out when to click the left button to paste and the right button to cancel, or that the right button pastes but the wrong tool is active. And yes, sometimes the left button pastes and sometimes the right, and, most of the time, the right button cancels the operation.

Animator brings the capabilities of a video studio down to the PC level. A lot of powerful stuff is packed into the Animator toolbox. As the tutorial advises, "During your first weeks with Autodesk Animator, explore the program..." With a program as complex as Animator, expect to take several weeks to figure out what you can accomplish and how you can do it.

However, some of the user interface is not as well thought-out as it could be, and this makes Animator harder to learn. Nonetheless, the extensive combination of tools, inks, effects, and commands makes it practical for the amateur with more imagination than ability to create spectacular visual effects and incredibly complex animations. ■

Sue Rosenberg is a consultant at James Martin Associates in Reston, Virginia. She can be reached on BIX as "suer."

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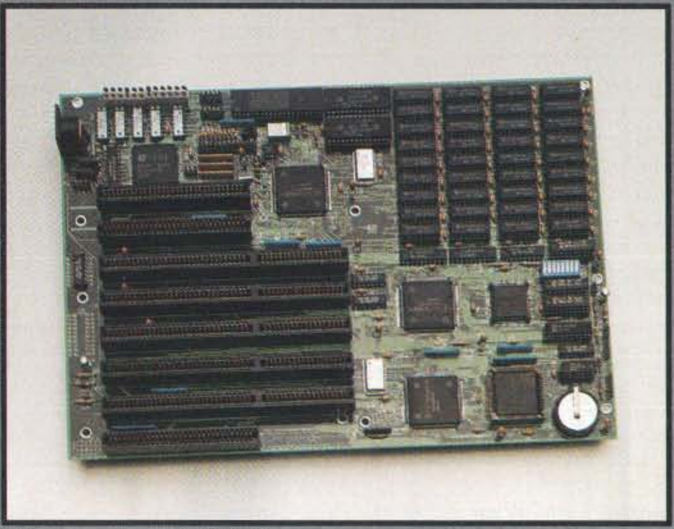

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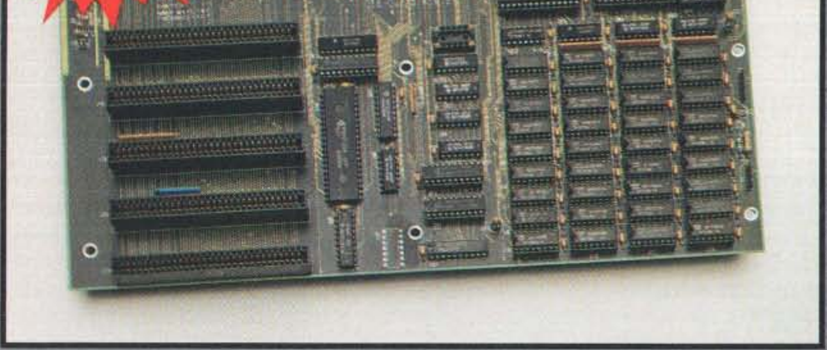

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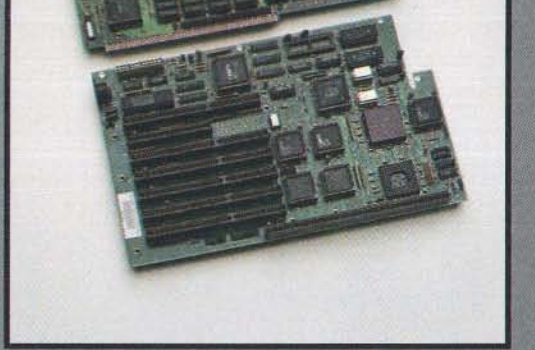

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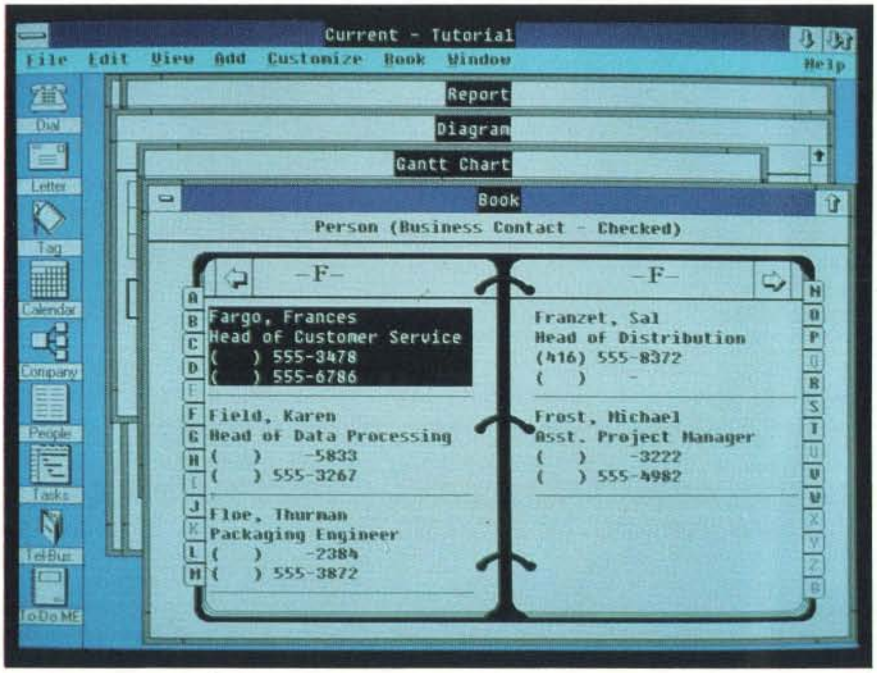

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Current organizes a variety of information for you.

You would expect that any software from IBM would have to be memorable. Current 1.00, a $395 personal information manager (PIM) running under Microsoft Windows, is certainly that.

Current is an astonishing grab bag of desk-accessory-style functionality. Pictorial, numeric, and text databases; appointment calendars; telephone dialers; address lists; form letter generators; and hypertext—you name it, and it's probably there. You can invoke this functionality with a few mouse-clicks.

The downside is that Current's functionality is wide but not deep, and you have to work Current's way or not at all. For most users, this might be just fine—a simple-to-use package that lets you immediately computerize most of your office work. Depending on how you use your computer, Current may be either the answer to your prayers or too simplistic to merit a second glance.

I ran Current on a 16-MHz Club American 386 with 3 megabytes of RAM, Hercules monochrome graphics, and a 30-millisecond, 40-megabyte hard disk drive running Windows/386 2.11. Although a mouse is not required, I used one for this review.

The Current World

With Current, you organize data around categories, which are broken down into items and fields. If you rendered your business card collection as a category, each card would be an item, and a field would be an individual entry from that card, such as the name or phone number.

You relate items in separate categories to each other through connections. If you have a "to-do" list category, you can set up connections between the people you need to contact and their entries in your business card category. Then, while looking at an item in one category, you can call up any connected items in the other category. Suddenly, you have a crude form of hypertext (computerized footnotes).

Meanwhile, your categories are presented in six formatted views: report, list, book, calendar, Gantt chart, and connection diagram. Report and list are listings of the items in a category, with the list view being limited to two fields per item. The book view shows the information as a too-cute graphical representation of an open address book. The calendar is just that, and the Gantt chart is the graphical representation of any scheduling data in the category. The connection diagram shows the connections in force, although the underlying category items can also be brought to the surface. (A seventh view, the detail window, shows the contents of an individual category item.)

Before items in a category are presented in a view, you can run them through a filter. They can also be filtered on the basis of the connections in force.

All interactions take place through dialog boxes, where you input text in a field, or point and shoot at a choice in a list. The views appear in their own pop-up windows, and you can stack one window atop another as you follow more connections. If you don't have Windows,

continued

you can still run Current, since Current includes a single application environment version of Windows. But with Windows, you can take advantage of the Windows clipboard, which lets you import text and graphics from other programs. (Aside from a mainframe terminal emulator, Current is the only IBM software offered under Windows.)

Categories and Connections

Current supplies the building blocks for creating your own categories in the form of *field types*. Each item in a category is made up of a selection of fields, and each field can be one of 13 different types. There is the usual text, time, date, numeric, and currency formats that you would expect from most database programs. But from there things get interesting. (Current, incidentally, cleverly interprets your input to the data fields, so that it knows the exact date if you type "Thursday" or even "two weeks from Thursday.")

An image format lets you load any graphical image imported via the Windows clipboard into an image field, in effect creating an image database.

A field can also be set equal to a cell in Microsoft Excel, the Windows-based spreadsheet. The contents of the field will change as the cell changes. Similarly, a *calculation* field derives its numeric contents from other fields using a formula that you specify.

You can set up a field as a set of radio buttons (i.e., fixed options that you define, of which only one can be "set"), or as a check box (to indicate a yes or no status). A data-file format lets you set the field equal to a data file of another Windows program, and an attempt to view the field invokes that program in a new window.

You can use the special telephone number format in conjunction with Current's automatic dialer, assuming you have a Hayes-compatible modem. Another special field can represent the contents of a canned form letter.

So, if you were a real-estate agent, you could set up a "properties" category. The image format could contain pictures of the houses you carry. A text field could carry your comments. Currency fields could carry pricing information, summed in a calculation field. Check boxes could indicate whether or not a house has central heating. With a wider range of options, you would use radio buttons to show, for instance, whether the roof is wood shingle, composition shingle, metal, or tile. And you can do all this with a few mouse-clicks.

Current supplies the building blocks for creating your own categories.

Provided that you also keep a category of prospects, you would want to keep track of who has looked at what house. To accomplish this, you can define connections that state relationships between an item in one category and an item in another. In this particular case, you would define—by invoking the correct command and filling in the blanks presented by various dialog boxes—two connections: "Houses—Visited By—Prospects" and "Prospects—Who Visited—Houses." In other words, each connection is two category names connected by a verbal phrase.

Using other dialog boxes where you again select category items from lists, you can connect the houses that clients have visited with the potential buyers. Then, any time you call up the detail view of a particular item, Current lists the connection associated with it at the bottom of the window. Clicking on an entry in this list will bring up a window showing the connected items in the other category—the visitors to this house, for instance. Then you can call up the detail view for each visitor. From that screen, you could examine the detail views of any other houses that person has visited—going in circles if you like, piling window upon window. Or you can follow the trail of any other connections associated with that person.

Connections need not be assigned manually—an automatic connection assigner will use rules that you specify. For instance, you can connect all houses with tile roofs to prospect Joe Kiln, because you know that's what he wants. You can apply the rule to existing categories and then leave it in force so it's automatically applied to new entries.

Viewing Filtered Data

Connections are especially useful when it comes time to look at your data—to list the items in a category. You can, in this case, list only the houses that a certain prospect visits, or the prospects who visited a certain house. After the items are listed, you can call up the detail screen of individual items and start following the connection trail.

But what if you want to see all houses within a certain price range and within a certain ZIP code? To create such an ad hoc display, you can use filters. A filter can involve up to four criteria concerning the contents of selected fields in the category. The kind of criteria that you can use are preset and depend on the field's format. With a currency or numeric field, you can filter for fields equal to, not equal to, greater than, or less than a given value. For a date field, you can filter for items that are on, before, or after a given date. For text fields, you can filter for items that contain, do not contain, or are equal to a given text string. Each field format works a different way. In this example, you'd use three criteria: one for the ZIP code and two (greater than and less than) for the price range.

When it comes to actually looking at the contents of a category, the report view is the most interesting. You can choose not only which fields will appear and in what order, but also which of four previously installed fonts will be used for that field and for the labels at the top of the page.

You can also have the report show the sum and average of selected fields. This immediately gives you a flexible flat-file database, since the calculation takes place after the filtering. Therefore, in a travel expense category, you could see the sum of all items that involved New York and took place in October. The views can also be printed out, although the book view is simply a listing of the fields and does not include the graphical booklet representation.

After defining just the view you want with various filters and display options, you can name and save it under an icon, to be summoned again with a mouse-click. You can also tag a particular view for later reference in the tagged-views windows, but the list is not stored on disk for later use.

Extra Functions

One of the field formats is the contents of a form letter. The letter can be defined as the contents of other fields in that category (e.g., name, address, salutation, and any other applicable field's contents that you have defined) plus the body text that you write. Current includes a basic word processor and spelling checker. You can send a letter to everyone in a category or to individuals, and Current can log the creation of each letter for later reference.

continued

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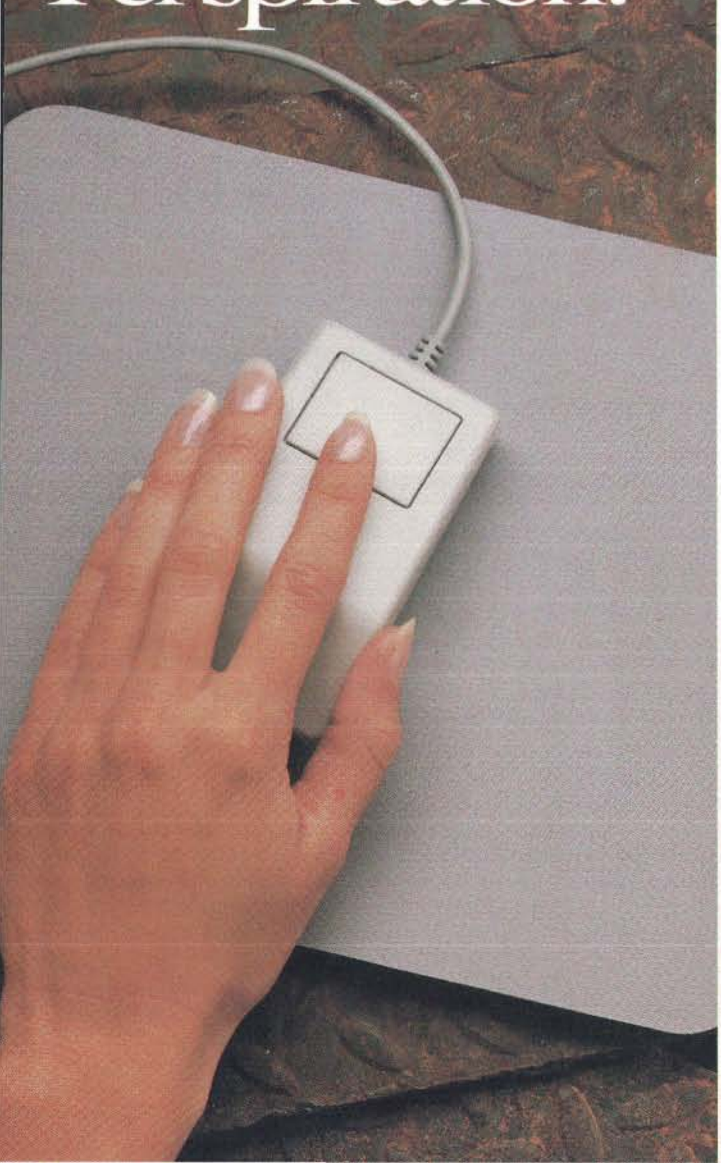

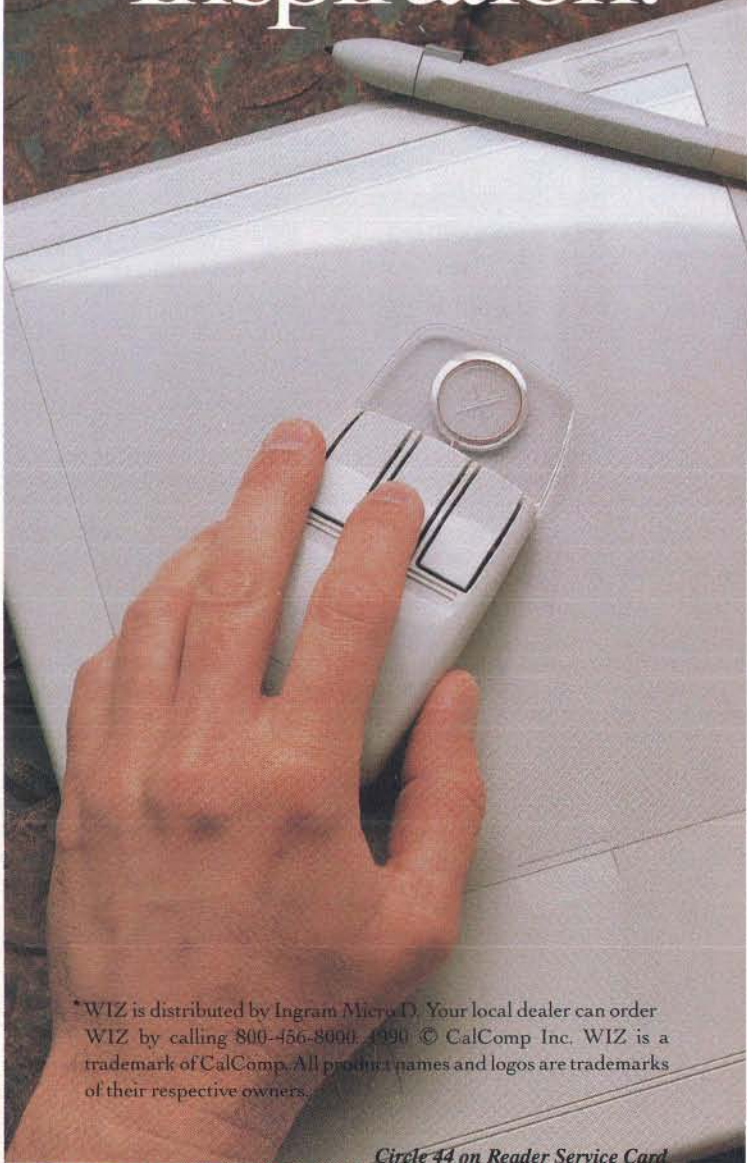

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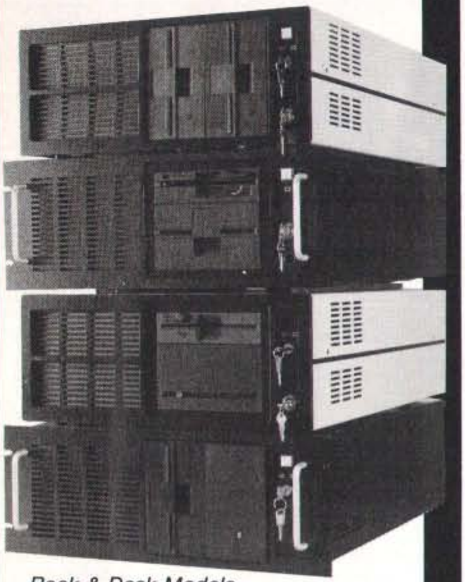

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The calendar breaks your day down into 5-minute intervals, or you can look at things on a daily, weekly, or monthly basis. As you log appointments, the calendar charts graphically how much of the day is booked and shows overcommitments. In addition, Current will beep you 5 minutes (or whatever interval you set) before a scheduled appointment. You can enter information into the comment field of each appointment and then connect the information to items in other categories.

Anytime you use the phone number field and automatic dialing, you can log in the time of the call and other information that you care to record. You can also log in incoming calls using a special menu command and pop-up window.

If you have a category with at least two dates per item (which can represent a start and end date of something), you can represent that category as a Gantt chart. Scheduling software often employs Gantt charts, but all scheduling here has to be manual—the Gantt chart is purely a display option. Another function lets you write an outline (presumably of some project) and connect each line to some category item—a sort of basic hypertext.

A Thin Coat of Everything

The designers of Current chose speed over data capacity. To ensure responsiveness, a category can only have 2000 items. More important, there can be only 27 connections employed in a category. If you want to probe a hard disk full of data with hundreds of keywords, Current is not for you.

The "2000 and 27 limit" might not seem onerous to most users, however, and it does indeed result in speed. Current sorted a category with more than 1700 items (about 100K bytes) on four filter items in about 12 seconds. (However, it took about 10 minutes to import that file from ASCII.) To do a simple sort of the file (from a report window) by field took only a couple of seconds.

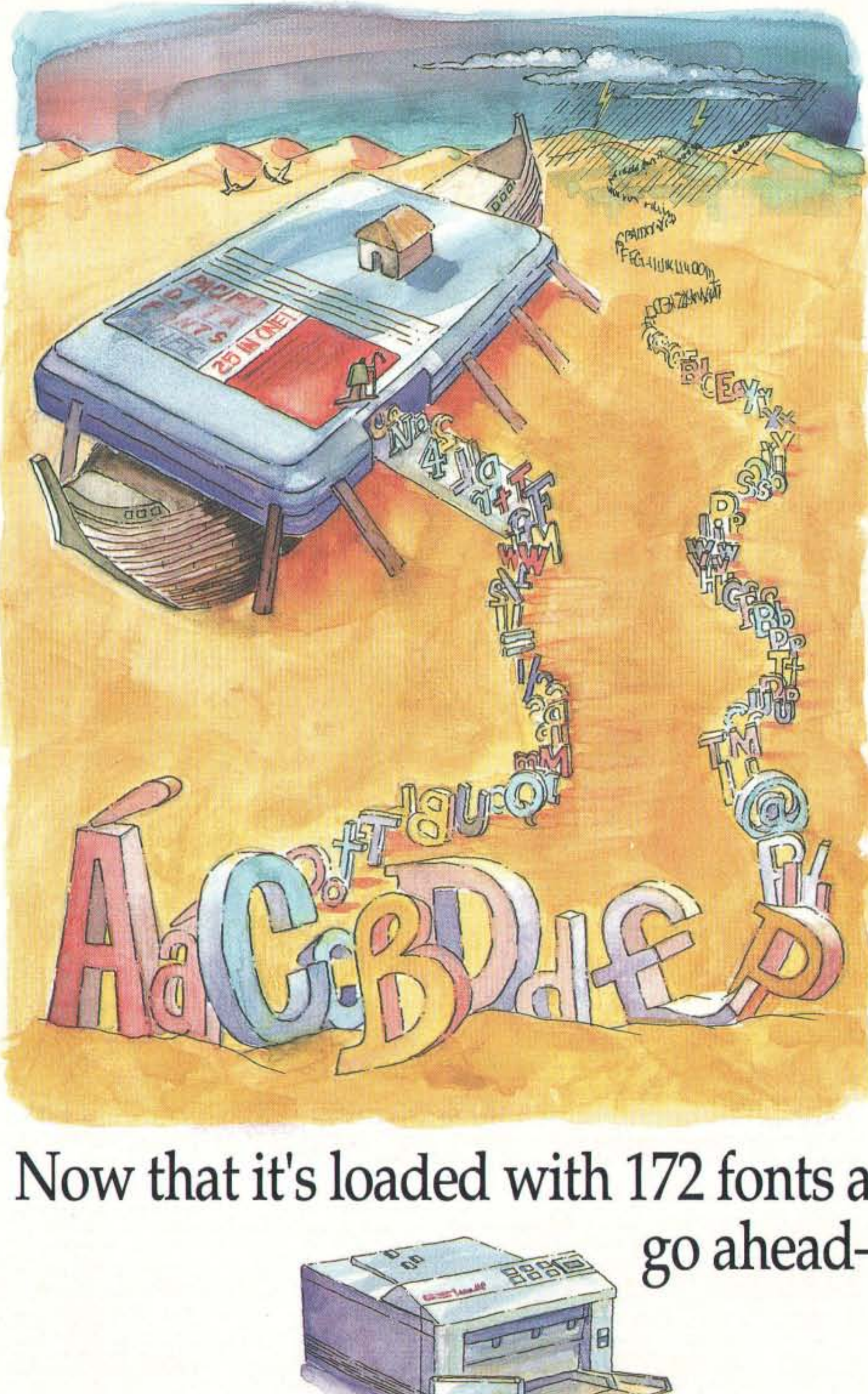
Current comes with context-sensitive help screens to coach you through every dialog box and has a thorough tutorial.

Current's word processor hardly improves on Windows' own notepad facility. (However, the form-letter text is accessible by the clipboard, so you can move it easily to a real word processor.) The report view can serve as a flat-file database, but it's limited to sorting, adding, and averaging the data—forget sophisticated trend analysis. The provision for a calculation field does not make Current a spreadsheet, since a calculation field cannot use the contents of another calculation field.

The idea of an image database becomes less intriguing when you learn that you have to load each image separately through the Windows clipboard. I also found clicking all the connections in dialog boxes to be tedious, and the limit of 27 connections began to seem merciful. You can load data from the clipboard, but only one field at a time. You can import raw data from DIF, dBASE, and ASCII files, but the system's rigidities get in the way. For instance, each item has to have a "name" field. My dBASE financial transaction file did not have unique names for each transaction, so I reformatted it to assign an ID number to each one. Current imported the ID numbers as text (names have to be text, it turns out), and so, after sorting, the items were ranked 1, 10, 100, 1001, 1002, and so forth.

But you can't be all things to all users. Current is aimed at the person who needs to do many things superficially—a middle-level manager, for instance, who primarily oversees other individuals. (In fact, the tutorial examples concentrate on projects and the assigning of tasks to people.) If that description fits your job, then Current may be for you. Otherwise, you had better look for specialized software. ■

Lamont Wood is a computer journalist, desktop publisher, and data broker living in San Antonio, Texas. You can reach him on BIX as "lwood."



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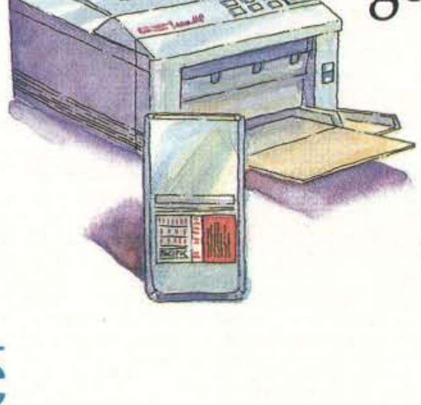

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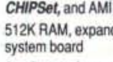

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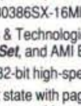

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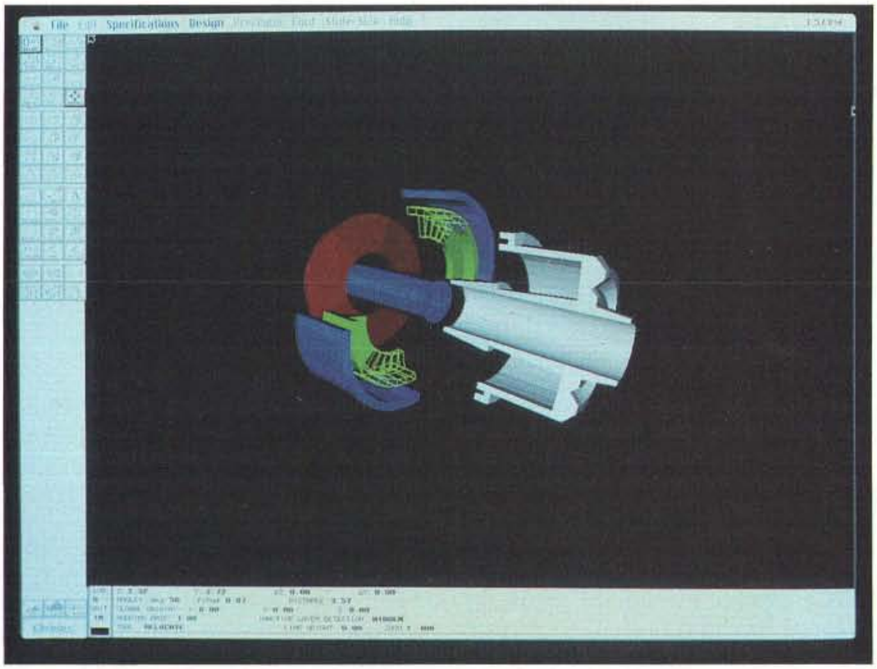

Origins can integrate wire-frame and solid geometry in a drawing.

It's tough to keep track of the explosion of programs in the Macintosh CAD market. Programs that handle two-dimensional mechanical and electrical drawings lit up the marketplace during 1988. The biggest PC CAD programs, AutoCAD and VersaCAD, were released as Mac programs. Major vendors, such as Claris (ClarisCAD), even jumped into the fray, taking on smaller companies' products, such as MacDraft, Pegasys, PowerDraw, MGMStation, and Dreams. Three-dimensional visualization programs, such as MiniCAD and SpaceEdit, were also released for the Mac. Even basic 3-D solids-modeling programs, such as Mac3D, found eager audiences.

Origins 1.0, from Deltasoft, is a new entry into this crowded Mac CAD market. It boasts the 2-D drafting prowess of AutoCAD and VersaCAD plus easy-to-use 3-D surface-modeling capabilities. Additionally, Origins' basic 2-D drafting functions are in a league with ClarisCAD's first-rate ease of learning and use. To make it an even more attractive package, Deltasoft sells the color version of Origins for only $595.

One thing Origins is not, however, is a true solids modeler. Although it does 3-D surface modeling and can integrate wire-frame, surface, and solid geometry together in any drawing, it lacks a solids modeler's geometric and construction orientation. Deltasoft expects to remedy this soon with an extension program called Origins Solids. You'll be able to access solids directly from Origins, so it will be fully integrated with Origins' surface-modeling features.

Origins lets an engineer, drafter, architect, or designer manipulate lines, points, and geometric primitives to produce precision drawings representing things as diverse as building floor plans, electrical system drawings, and mechanical systems.

The program includes the necessary tools for you to produce exact wire-frame and surface-model drawings. Origins does not include a numerical control interface, so you can't control machine tools, robots, or other mechanical equipment directly.

With Origins, full-time engineering professionals have the sophisticated CAD tools needed to draw the components and systems that others build. Unlike AutoCAD and VersaCAD, Origins is accessible to the casual user. Besides being easy to learn and use, Origins is less expensive than its immediate competition. It is priced far below AutoCAD ($2995) and VersaCAD ($1995). It even beats ClarisCAD's $795 price.

Drawing on Origins

Unlike AutoCAD, which is clearly a port of the PC version and retains that version's difficult interface, or VersaCAD, which adopts a minimalist interface approach (and suffers from Mac interface lapses of its own), Origins was designed from the ground up for the Mac. In fact, Origins will even run on a Mac 512KE and Mac Plus, something that VersaCAD and AutoCAD can't do.

When you fire up Origins, you will quickly get a display that automatically

continued

Origins 1.0

Company
Deltasoft, Inc.
P.O. Box 55089
Tulsa, OK 74155
(918) 250-5594

Hardware Needed
Mac 512KE, Plus, SE, SE/30, II, IIx, IIcx, or IIci with two 800K-byte floppy disk drives or one 800K-byte floppy disk drive and one hard disk drive; a math coprocessor is recommended

Documentation
User's guide; reference card; quick-reference guide

Price
$595

Inquiry 889.

sizes itself to take advantage of all your screen real estate. On my 19-inch SuperMac color monitor, Origins filled the screen from side to side and top to bottom with its menu bar, tool palettes, and four view drawing windows (e.g., top, bottom, side, and orthographic/perspective views).

The Origins menu bar contains the usual File and Edit items, plus Specifications, Design, Precision, Font, Style/Size, and Help. On-line help is particularly strong, and a separate HyperCard learning stack augments it.

To create a new drawing, you just go to the File menu and select the submenu "Create a New Design." Then you start using Origins' built-in palette of lines, 2-D and 3-D objects (e.g., rectangles, circles, ovals, triangles, cylinders, cubes, pyramids, polygons, arcs, Bézier splines, strings, and 3-D surfaces), and symbols to construct your design. You convert 2-D drawings into 3-D surfaces using the extrude tool. All the geometric primitives allow composition attributes, such as hollow-shell, solid-parallel frame, or solid, so you can flesh out these objects to look the way your design requires. I put together a simple 2-D drawing of a house in about an hour, without even pulling the shrink wrap off the manual.

Once you've created your drawing, you can then spruce it up so that it goes from being a simple affair to a real drafting image. You can automatically calculate and display your object's dimensions, annotate sections, and rescale everything in either English or metric measurements.

Editing and modifying drawings are also a snap with Origins' combined point and object orientation. *Object orientation*, similar to the object orientation of more familiar Mac drawing programs, lets you move individual objects around on the screen, relative to all the other objects you've created. *Point orientation*, on the other hand, is one of Origins' big claims to fame. With point orientation, you can select a cluster of points or a single point to be modified within an object. I don't know of any other Mac CAD program with this useful editing feature.

Like other Mac CAD programs, Origins has a full set of editing and basic 2-D geometric functions. You can translate, rotate, resize, skew, tilt, fillet (and inverse-fillet), extrude, mirror, duplicate, zoom, pan, chamfer, and flip your drawings and parts of them. Since you can also specify precise geometric parts with Origins, it's easy to find intersections, centers, percentages, and other locations within a complex geometric drawing.

Origins supports all the industry-standard paper sizes for plotting and printing, plus many other custom sizes that you can define. You can select any line widths you like, along with customized fill and crosshatching patterns. You can also plot up to 256 layers in a single drawing so that you can use Origins for electronic CAD; however, it does not come with the special electronics symbol libraries needed for PC board or VLSI design, nor does it include VLSI cell geometric and optimization functions.

Origins will print to practically any Mac-compatible printer and most Mac-compatible plotters, including my Hewlett-Packard 7442 eight-pen flatbed plotter.

> *When you fire up Origins, you get a display that automatically sizes itself to take advantage of all your screen real estate.*

3-D Prowess

Although Origins can't do *true* solids modeling, it does integrate wire-frame, surface, and solid geometry in a unified database representation. The program also supports math coprocessors for making these unified calculations. Origins' 3-D surface-modeling capabilities let you create and render both wire-frame and shaded 3-D surface models. To make these renderings more realistic, Origins removes hidden lines automatically.

Solids modeling takes into account the properties or characteristics of the solids it has modeled, so that data such as mass, center of gravity, and surface tension can be evaluated. In other words, solids modeling tries to deal with the world in real terms. On the other hand, 3-D visualization techniques do not. You can make a 2-D or 3-D wire frame appear as a solid model using 3-D visualization techniques; you can then move the object around in space to get a better idea of how it should be microdesigned. The difference is that 3-D visualization techniques don't process any information about the properties of the solids you have rendered, so you don't know the mass or center of gravity for a particular object you've created on the screen.

A separate 3-D viewing mode, where you can't edit the renderings, lets you view vector, raster, or PICT2 3-D files. Like 2-D designs created within Origins, such 3-D views allow for real-time rotation, panning, and zooming. You can even do cutaway, transparency, and perspective calculations that let you effectively "fly" about within a 3-D surface model and examine it from different viewpoints. This capability comes in handy for architectural CAD, where you need to validate interior designs.

The biggest problem with Origins' 3-D solids viewing is the time it takes to solidify a wire-frame drawing. My simple house drawing, which contained fewer than 300 primitives, took almost 30 minutes to render as a solid. Once rendered, it was easy to zoom, pan, and manipulate the view, but that rendering time made the process far from interactive.

A more complicated drawing of the space shuttle *Columbia* (which I imported into Origins using the Claris Graphics File Translator, since Origins' optional file translator was unavailable at press time) was even more problematic when rendered as a solid. It took more than 4 hours to turn a wire frame into a partial wire-frame, partial cutaway solid rendering. This drawing was composed

continued

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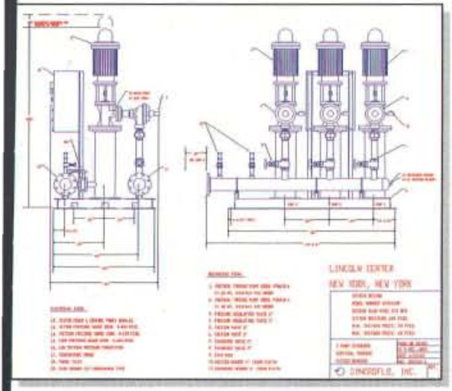

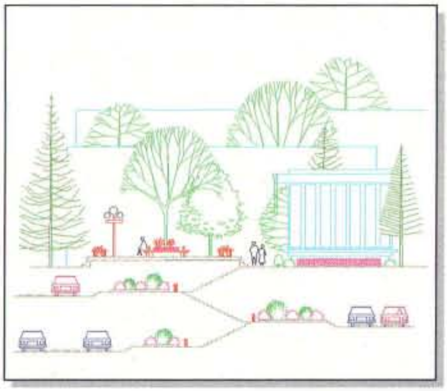

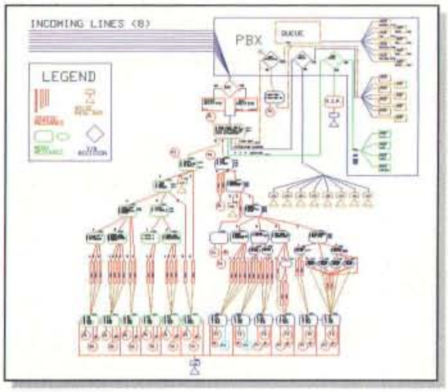

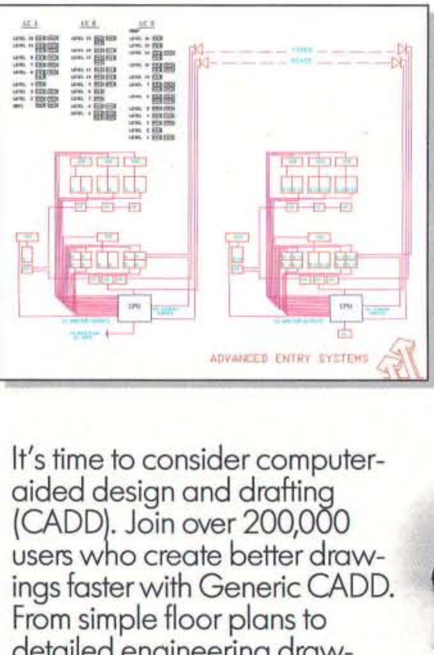

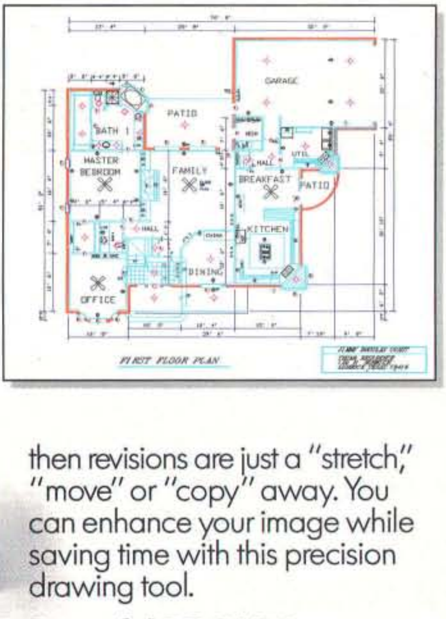

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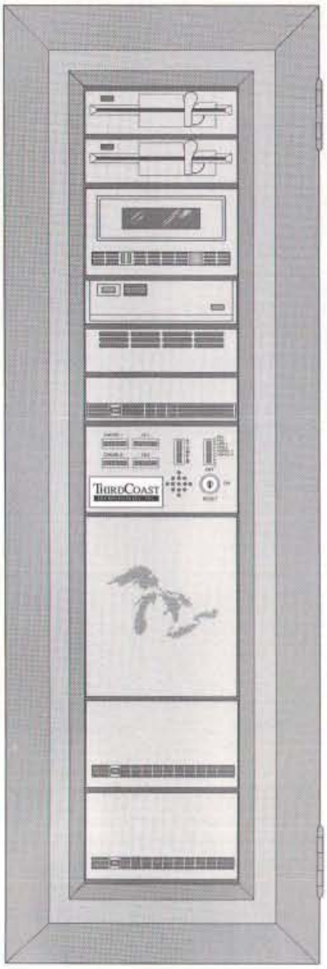

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FAST ORIGINS

Origins proved notably faster than AutoCAD and VersaCAD working with a drawing of the space shuttle Columbia. *(Times are in seconds.)*

	Open file	Save file	Redraw	Zoom window (50 percent) and redraw	Pan left to right
Origins	6	1.2	1.8	2.5	1.9
AutoCAD	49	2.3	2.5	3.3	3.0
VersaCAD	20	6.7	4.8	5.0	N/A

Notes: All benchmark results are the average of 10 timings and were made using a half solid, half wire-frame drawing of the space shuttle *Columbia*, originally rendered in AutoCAD and saved in IGES and PICT2 formats. All three packages were tested on a Mac II with 8 megabytes of RAM, a 40-megabyte Apple internal hard disk drive, a 180-megabyte Jasmine external hard disk drive, a SuperMac high-resolution 19-inch color monitor, a SuperMac Spectrum/8 NuBus video card, System 6.0.3/Finder 6.1, no MultiFinder, no RAM cache, and minimal fonts, cdevs, and INITs.

N/A=not applicable.

of over 2000 primitives, so it's a fairly complicated design.

Despite the poor speed of its 3-D solidification, Origins is fast. Deltasoft claims that its generally good performance is because Origins is written in 68000 assembler code. Indeed, Origins was faster than AutoCAD, VersaCAD, ClarisCAD, Dreams, and most other 2-D CAD programs I tried. To give you some idea about Origins' speed, I timed several functions using the *Columbia* drawing (before it was made solid) and compared those to the same timed functions in AutoCAD and VersaCAD. The results of these benchmarks are shown in the table. By and large, Origins was faster than either program at every timed task.

Compatibility and Glitches

Origins saves files in its own format, and it uses Clipboard, PICT, and PICT2 files directly. It can't, however, read IGES, DXF, FEA, CAM, or other CAD format files directly. Deltasoft sells a file translation program to overcome this file compatibility problem, but it wasn't available when I wrote this review. In contrast, AutoCAD and VersaCAD can both read and write to IGES files, which have become a sort of industry standard in CAD file interchange.

The program is quite slow on anything less than a Mac II–class machine (including the SE/30), and you'll really miss not having color capabilities for rendering different layers and objects. Origins works best on an 8-bit color Mac II, IIx, IIcx, or IIci, with a large-format high-resolution RGB monitor.

I ran into several annoying glitches while testing Origins; most of these occurred while using the *Columbia* drawing. The program would freeze, the cursor would die, the screen manager would get trashed, and the drawing window would go blank or the entire screen would break up, requiring a hard reboot.

After spending almost a week trying to get help from Deltasoft's technical-support line, the company finally got back to me with a fix. Under MultiFinder, you can't use the program with the default memory size (1024K bytes). Increasing the MultiFinder region to 2048K bytes fixed those problems. During benchmark testing, though, I did not use MultiFinder.

I also ran into several other annoying little quirks that mostly involved screen redraws jerking along. Deltasoft did not have any fixes for these quirks, except to say that a bug fix release would be available sometime this year once the Solids program has been released.

If you need direct compatibility with IBM PC CAD programs, then you'll be better off buying either of the much more expensive AutoCAD and VersaCAD programs. Even the most accurate file translation programs will lose some of your geometric database when you translate from these formats to Origins. If you don't need IBM PC CAD compatibility and want an easy-to-use and powerful 2-D CAD and 3-D surface modeler, then Origins is quite a buy. If the promise of Origins Solids is fulfilled, you could put together a full-fledged 3-D solids-modeling system on your Mac for well under $1000. That's quite a feat. ■

Don Crabb is the director of laboratories and a senior lecturer for the University of Chicago department of computer science. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

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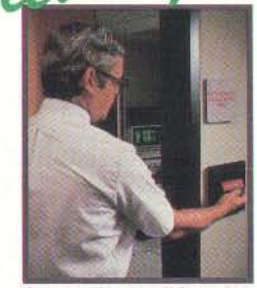

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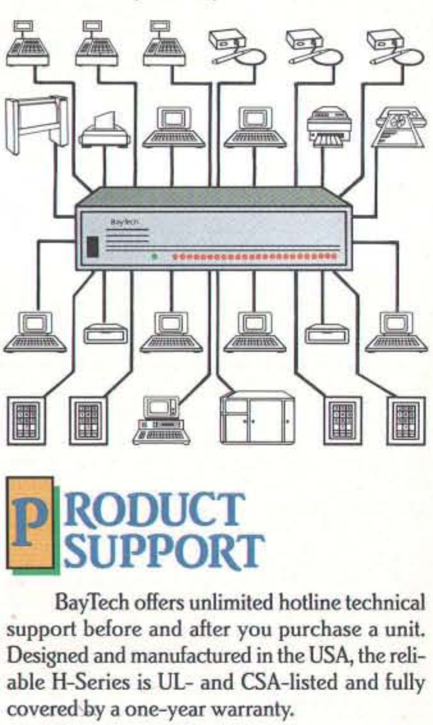

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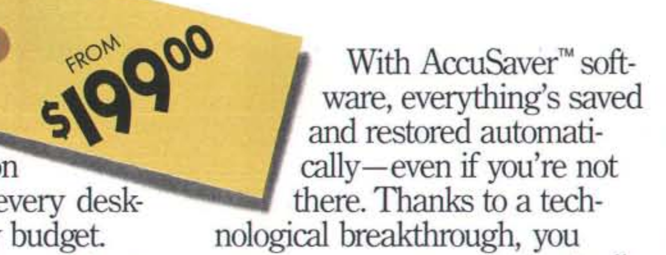

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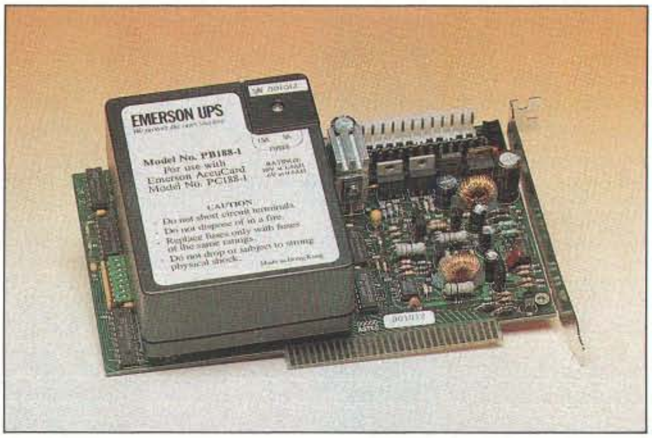
Reviewer's Notebook

Reviewer's Notebook is a compilation of brief reviews and updates to previously published evaluations. BYTE will publish Reviewer's Notebook each month as space permits.

Where Were You When the Lights Went Out?



The Emerson AccuCard fits inside your PC and provides backup power.

The slings and arrows of outrageous (or nonexistent) AC line power make a backup power supply a necessity if you use a computer for more than a few hours a day. With the heavy-duty batteries and electronics needed to keep a fully loaded PC running, most backup power supplies are big, heavy, expensive, and ugly.

Emerson Electric, a venerable name in electrical appliances, has taken a different approach to backup power supplies. Its AccuCard fits *inside* your system unit.

AccuCard's battery measures 1¾ by 3 by 1⅜ inches and plugs into the side of a half-length PC add-in card. This makes for an odd, side-heavy arrangement that nonetheless is a perfect fit for the rightmost (next to the power supply) expansion slots in most standard PC cases.

Installation was easy. I just unplugged the power connections to my system's motherboard, plugged them into the AccuCard, and used a patch cord to connect the AccuCard to the power connections.

A battery this small simply doesn't have the capacity to keep a fully packed system powered up for a long period of time, so Emerson does things differently. Included with AccuCard is AccuSaver, a memory-resident program that takes up a paltry 8K bytes of RAM. If the AC line power to your system fails for more than 1 second, AccuSaver kicks in and saves an image of your machine's state (registers, RAM contents, and so on) to disk. It then shuts down the system. The whole process usually takes less than 15 seconds, depending on how large your system's memory (and how fast your hard disk drive) is.

When the AC power returns, the AccuSaver software restores your system to where it was when the lights went out. It works flawlessly. My AT clone has a board in every slot. Even though AccuCard is rated at 86 watts, it had no problems when I unplugged my system's power cord. When I plugged the cord back in, I was quickly returned to where I'd been. If you're worried about data security, AccuSaver's setup software gives you the option of password access before it restores the system.

At $249, AccuCard costs about half as much as a standard backup power supply, and its autosave feature offers distinct advantages over the usual manual method of saving data and shutting down a system during a power failure. But AccuCard is not a magic answer to power glitches, nor does it claim to be. It does not have built-in surge suppression. (But because it floats full-time on the DC lines, it does act as a buffer between the motherboard and the power supply.)

Since AccuCard is designed for a single user, you still need a standard backup supply for a file server or a multiuser system. But AccuCard is inexpensive and easy to install, and it does what it claims. And if you've ever lost a day (or more) of work to a power failure, you know that $249 is a reasonable investment for peace of mind.—*Stan Miastkowski*

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A Disassembler for the Curious

Professional programmers have long relied on disassemblers to unravel machine language instructions and view generic assembly language. But simple disassemblers, like Microsoft's CodeView, won't help you examine the result of a program's I/O calls, the invocation of operating-system functions, or complex jumping or branching sequences.

continued

Enter Dis-Doc Professional, a standalone disassembler that quickly takes apart complete programs. Dis-Doc recognizes .EXE, .COM, and device-driver files, and it includes a utility to unpack LINK-compressed .EXE files. Dis-Doc names branch labels with a letter and a hexadecimal label address, so the labels are in numerical order and easy to find.

I had some trouble with the installation program hanging my system; the installation software crashed if I denied it permission to change my AUTOEXEC.BAT file. But once it was installed, Dis-Doc loaded and ran without any problems. To start, I used something simple: the standard MS-DOS TREE.COM program. Dis-Doc disassembled the file in its interactive window. Here, I used cursor keys or my Microsoft Mouse to move the cursor about and look at the code that Dis-Doc generated. Since the program recognized TREE.COM as a .COM file, it knew what registers the file would contain and commented the source code accordingly. For example, a PUSH BP early on in the code was commented to `; Save the argument pointer.`

Dis-Doc paused at times to disassemble more of the file as I scrolled. While annoying for a small file, it lets Dis-Doc disassemble even the largest executable files without running out of memory.

After viewing the file, I saved the assembly output as a file. I was impressed that the program assembled without any trouble or editing. The convenient Edit menu let me add labels and change data types. If the assembler had incorrectly marked a listing area as data, I could easily rename it as program code (or vice versa). Also, if Dis-Doc marked a range of data as code, I could use the Data Block choice in the Edit menu to change the designation to initialized data.

The package is designed to review small sections of existing code, rather than to completely reengineer existing applications. Nevertheless, Dis-Doc provides strong support for disassembling BIOS code. In fact, I wonder if Dis-Doc uses canned information to recognize common BIOS sets, as it appeared to more clearly comment and more accurately analyze BIOS code. Unfortunately, this disassembly was noticeably slower than the disassembly of a file, presumably because of the size of the BIOS.

Overall, Dis-Doc is a good tool for the curious. It isn't powerful enough to completely disassemble many applications, but it can be great for studying existing programs. Those interested in exactly how their BIOS works will find it useful in disassembling the ROM programs.

—Michael Blaszczak

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Flat Color Display Brightens Macs

ColorPage 15 from E-Machines provides a 15-inch, flat-screen display and impressive color for Mac users who might otherwise settle for Apple's 13-inch color monitor. Obvious ColorPage benefits are its 768- by 576-pixel resolution (versus Apple's 640 by 480 pixels) and its larger format—a full page, compared to the three-quarter-page Apple display. But the $2095 price may be high enough to make Mac users think twice before choosing the ColorPage.

The monitor and video board display 256 out of 16.7 million possible colors. The monitor's noninterlaced refresh rate is 67 Hz, with a horizontal scan rate of 41.6 kHz. Dot density totals 72 dots per inch, while dot pitch is rated at 0.31 millimeter. The monitor provides a 32-bit-wide data path. ColorPage rests on its own tilt/swivel stand and ships with a video board and cable. A utilities disk includes brightness and contrast controls that you can access through the Mac's Control Panel. Like other NuBus boards, the video board slips easily into place, so monitor setup is quick and uneventful.

If you're new to flat-screen monitors, allow yourself time to adjust to an FTM (flat tension mask) display before passing judgment on image quality. Our eyes have learned to ignore distortions caused by traditional monitors, which bow out in the middle. When I first fired up the flat ColorPage, the screen looked positively concave. My eyes remained convinced of this illusion even after I slid a ruler along the screen, proving the glass was flat. After a couple hours, my eyes no longer registered the distortion. Instead, they reeled at traditional monitors' ungainly images, which now looked inflated, like people in carnival mirrors.

The Zenith-made FTM screen and antireflection coating produce rich, warm colors. E-Machines redesigned the electronics for the Mac. I ran the ColorPage and the 13-inch Apple monitor side-by-side on a Mac IIci, which enabled me to split color images between the two screens. I compared PixelPaint Professional files and found that hues blended together more smoothly and lines looked crisper and better defined on the ColorPage. Colors on the Apple were blotchy, with sharp contrast between similar tones. In addition, blues tended toward green and browns flared to red on the Apple. ColorPage colors appeared truer.

When I displayed Aldus PageMaker text files, the ColorPage showed some flaws. Clearly defined letters in the screen's center became blurred when I moved them to the screen's edges. However, except for this border distortion, the ColorPage's color and sharpness outmatched its competitor's.

E-Machine's ColorPage monitor for the Mac provides glare-free images and rich colors.

The ColorPage is over twice the price of Apple's 13-inch monitor, but E-Machines believes the better resolution and full-screen display will encourage Mac users to pay the difference for precision in designing overhead presentations and reports. Many Mac users, I suspect, will consider The ColorPage a well-designed but expensive luxury.*—Alan Joch* ■

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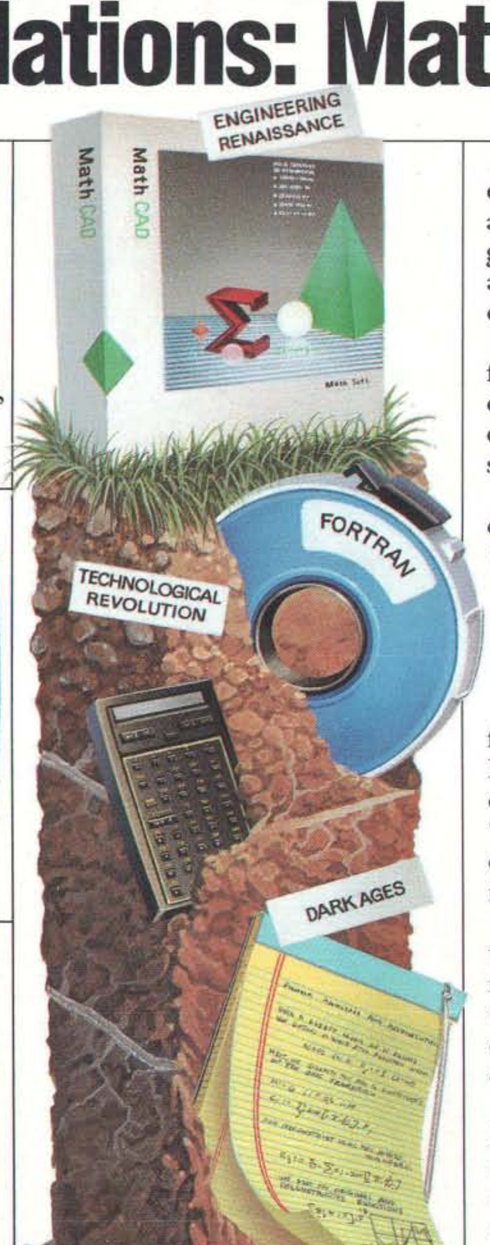

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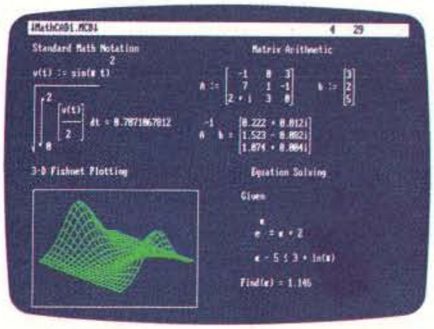

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IMathCAD1.MCD                                   4   29
Standard Math Notation              Matrix Arithmetic
```

$v(t) := \sin(\pi t)^2$

$\sqrt{\int_0^2 \left[\frac{v(t)}{2}\right] dt} = 0.7071067812$

$A := \begin{bmatrix} -1 & 0 & 3 \\ 7 & 1 & -1 \\ 2+i & 3 & 0 \end{bmatrix} \quad b := \begin{bmatrix} 3 \\ 2 \\ 5 \end{bmatrix}$

$A^{-1} b = \begin{bmatrix} 0.222 + 0.012i \\ 1.523 - 0.002i \\ 1.874 + 0.004i \end{bmatrix}$

```
3-D Fishnet Plotting                Equation Solving
```

Given

$x^x = x + 2$

$x - 5 \le 3 \cdot \ln(x)$

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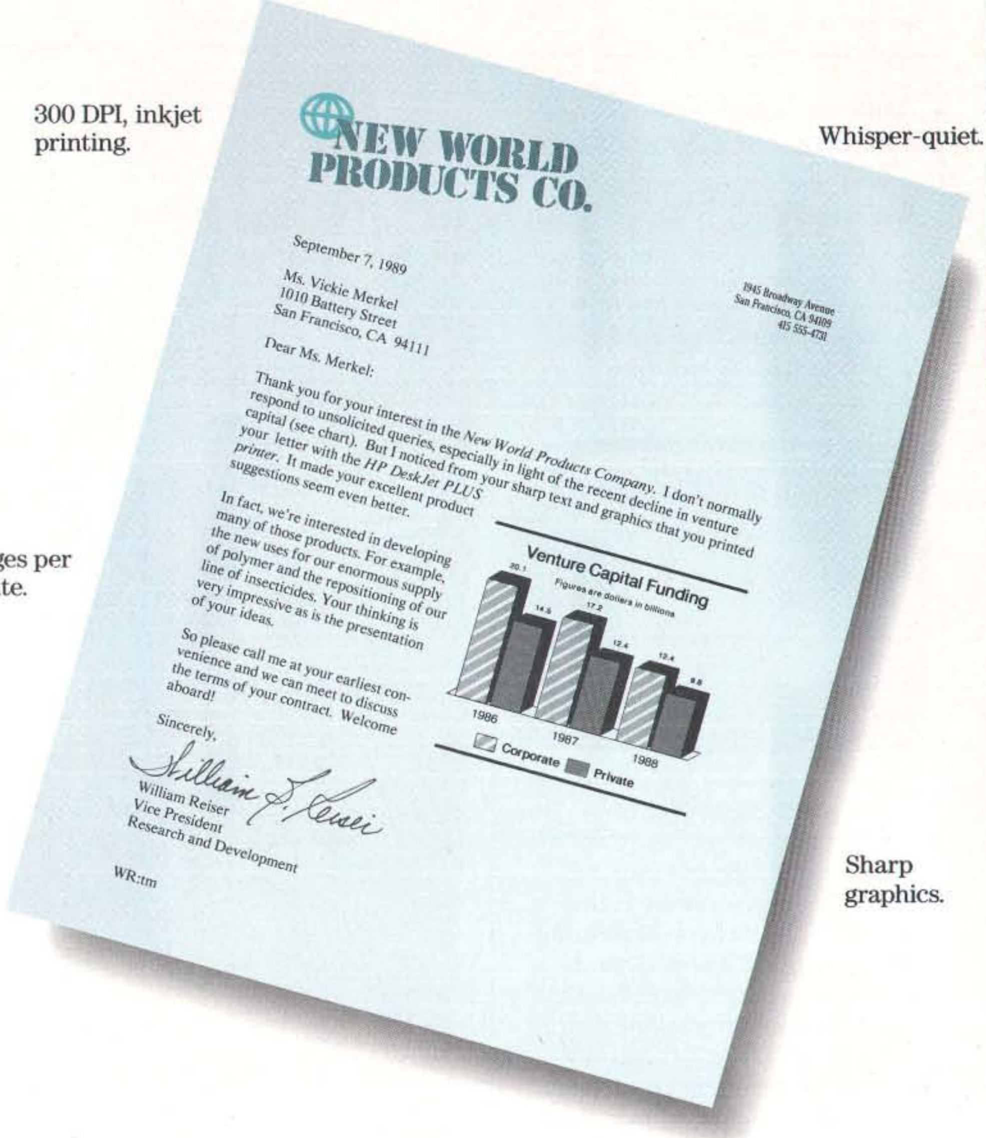

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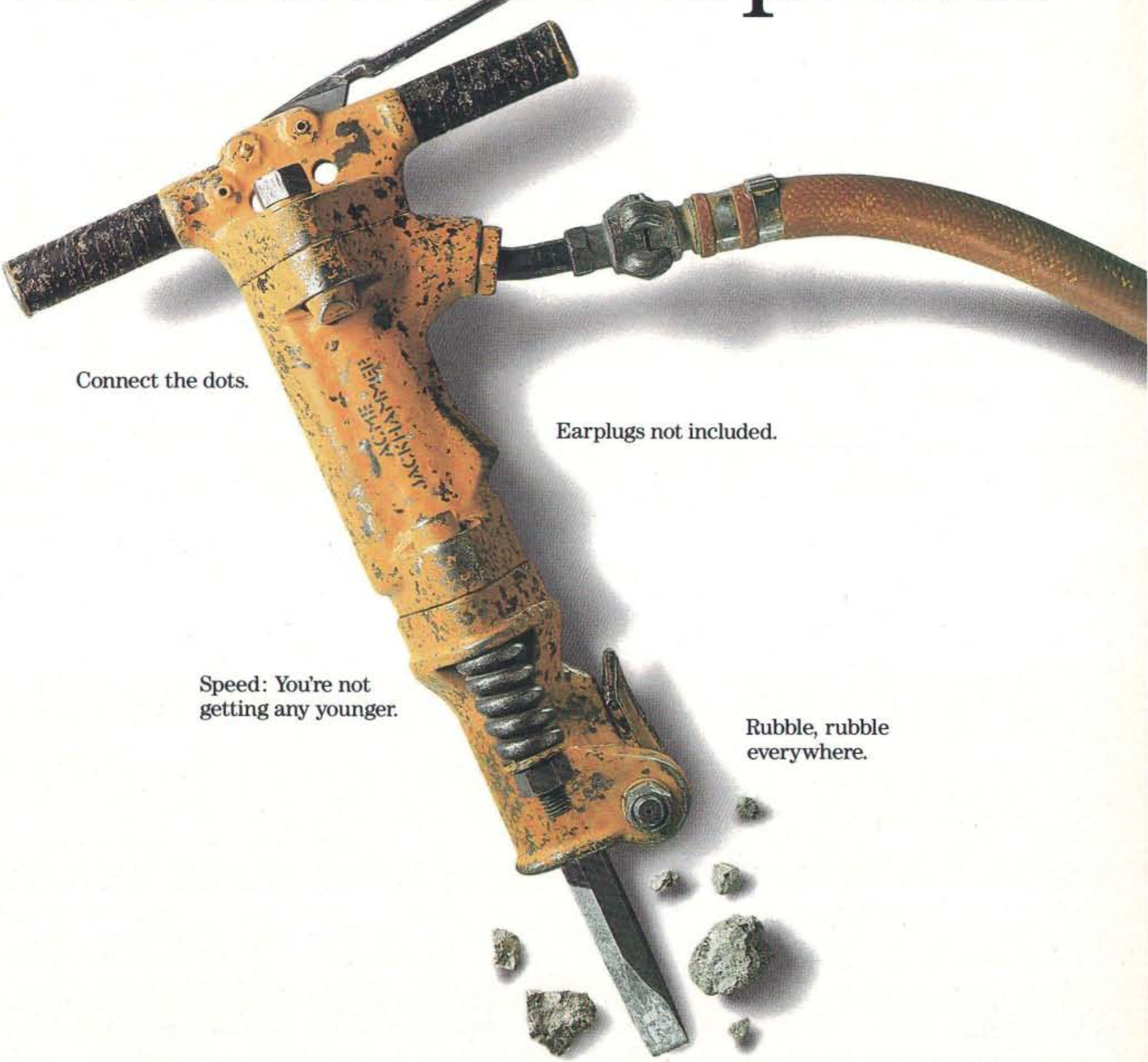
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IN DEPTH

Life Within 1 Megabyte

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At a time when an economic slowdown is creeping across the nation, rumors of the death of the 80286 have been greatly exaggerated. For many people and companies, now is the time to get as much out of current computer systems as possible—whether they are ATs, Macs, or smaller machines—not to dump them for the latest and greatest.

Getting more out of equipment you already have can be a challenge, especially if you're running at near capacity now. Careful planning and the use of some of the techniques described in this special In Depth section can significantly extend the life of your current computer.

The section begins with "The Succession Crisis," in which Bob Ryan sets the stage for the space-saving tools and techniques explored in this section. He looks at the ongoing battle between OS/2 and Unix for the title of King of the Desktop. The big question is, can either of them unseat MS-DOS?

Then, in "Expanding the Limits," Jeff Holtzman describes ways to work around the frustrating 640K-byte DOS limit on a 1-megabyte machine without changing to another operating system. Both hardware and software solutions exist.

Next, in "Mac at the Minimum," Tom Thompson examines the 1-megabyte limit from a different viewpoint—the Macintosh's. MS-DOS users aren't the only ones who have to work with memory constraints. The 1-megabyte Mac user must live with its limits as well. Tom looks at programs you can and can't run in 1 megabyte and provides hints to help you get the most out of what you have.

In "Easing the RAM-Cram Blues," Mark L. Van Name and Bill Catchings look at some DOS utilities that help you manage your TSR programs. A wonderful idea, TSRs, but they eat memory for lunch. If you're not careful, you can end up with RAM cram and no room for applications. These utilities and others can cure this terminal condition.

Then, in "Saving Space," Steven J. Vaughan-Nichols shows how data compression can save your disk from information overload and your budget from disaster. These utilities are too useful not to have—packing more information into less space on your hard disk—and some work better than others.

In "More Bang for Your Buck," Mark L. Van Name and Bill Catchings discuss some of the smaller integrated packages and how they can help you fit more functions into the memory space you have. The inexpensive packages described here include at least word processing, spreadsheet, and database functions—the workhorses of PC software.

Finally, in "Coping with Diversity," Bob Ryan looks at the age-old problem of compatibility between different machines from a different angle: interoperability. If you can transfer information easily and conveniently between different computers, why should you care whether the machines are compatible with each other? There are more options than you may realize.

There's no shame in keeping your current machine as long as it can do the job. It may not be as bright and shiny or have as many bells and whistles as the latest box off the assembly line, but it works, and that's what counts. A line from an old song seems particularly apt right now: "Let's hang on to what we've got."

—Jane Morrill Tazelaar
Senior Technical Editor, In Depth

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The Succession Crisis

OS/2 and Unix are both vying to replace DOS on your desktop, but the best choice may be no change at all

Bob Ryan

At every Comdex—Spring and Fall—since the spring of 1987, BYTE has polled attendees about which operating system they thought would be dominant in the future. The results of these polls (which are summarized in the figure) show how perceptions have changed over time. The most startling fact that comes out of these polls is that, although both the industry and users have been griping about its limitations for years, the combination of standard and extended DOS is expected to dominate the industry for the next few years.

This confirms the maturation of the computer industry over the past five years. Users are more interested in solutions than they are in jumping into the latest technology—you wouldn't describe DOS as cutting-edge. The result also has profound implications for anyone considering an upgrade to OS/2 or Unix. Quite simply, it may still be premature to choose either OS/2 or Unix over DOS.

Upgrade Downside

Just as it was in 1987 when the BYTE poll began, the decision to move to an inherently more capable operating system than DOS is still fraught with uncertainty. Whether you are a single user or a company with hundreds or thousands of DOS machines, upgrading is expensive. For a business especially, upgrading to OS/2 or Unix involves more than the cost of the operating system and necessary hardware; it involves a lot of retraining and frustration until everyone in the organization becomes settled with the new system. As the national economy comes in for its "soft landing," now may not be the best time to invest in new equipment or to move to a new operating environment.

One other major problem with switching to a new operating system is that you may be forced to leave some or all of your application base behind. Unless the applications you need are available under the new operating system, you may be out in the cold.

I will contrast the advantages and disadvantages of OS/2, Unix, and DOS from a practical standpoint. OS/2 and Unix are certainly technically superior to DOS, but that doesn't mean that either one is the right choice for you.

Heir Apparent

When it was announced in the spring of 1987, OS/2 was hailed as the operating system of the future. It corrected two major deficiencies of DOS—limited memory and lack of multitasking—and it promised to bring the ease-of-use features of the Macintosh interface to machines with Intel microprocessors. It also promised to run applications written for DOS. Although the cost of upgrading to OS/2 was stiff, it

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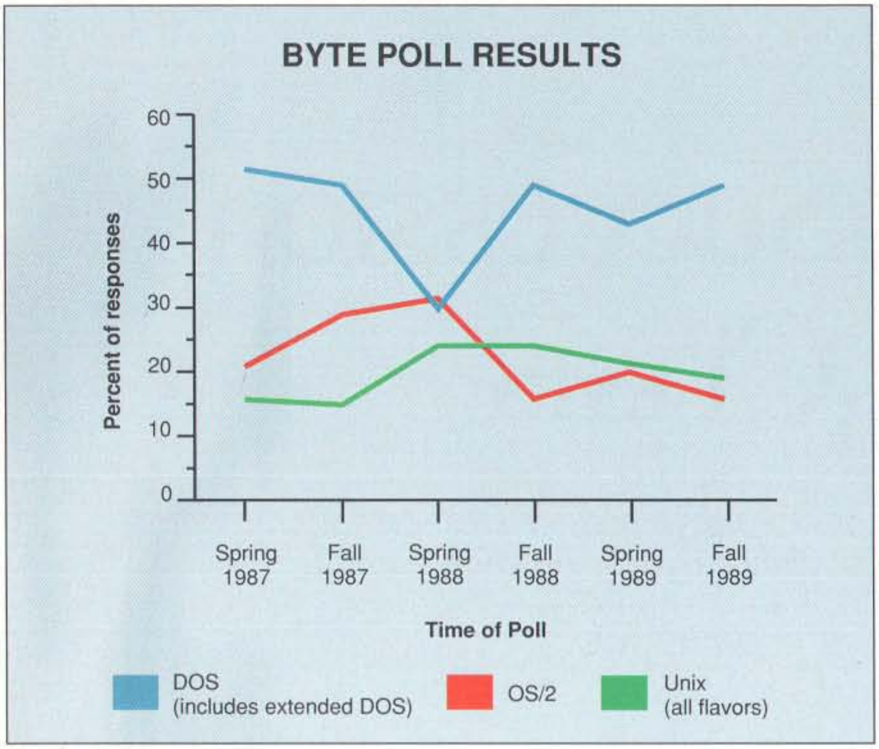

The expectations of Comdex attendees have fluctuated greatly in regard to OS/2 versus DOS. OS/2 hit its peak of popularity at Spring Comdex 1988, when voters chose it over DOS as the dominant operating system of the future. By the fall of that year, however, DOS had regained its former luster as problems with OS/2 became evident.

was thought that business buyers would pay the price in order to reap the advantages of the newer operating system.

Events—and some poor planning—have conspired against the acceptance of OS/2. RAM prices took off as chip companies had trouble bringing 1-megabit DRAM chips to market and after government attempts to protect the domestic DRAM producers failed. This increased the cost of upgrading to OS/2.

In addition, the DOS "compatibility box" was not as compatible as it should have been. DOS compatibility was of prime importance: If OS/2 could have offered complete DOS compatibility from the start, users would still have had applications to run until OS/2 applications were ready. As things turned out, the absence of true compatibility meant a lack of OS/2 purchasers, causing software developers to question whether OS/2 was the best place to put their resources.

OS/2 has also suffered because of the piecemeal way in which IBM and Microsoft have made it available. It took them over two years to get the Presentation Manager (PM) in place, thus giving users an excuse to delay committing to OS/2 and time to consider alternatives. Also, pronouncements by many in the industry that the 80286 was not powerful enough to use OS/2 to its best advantage has probably done more harm to OS/2 sales than it has boosted the sale of 80386 machines in anticipation of an 80386-specific version of the operating system.

The Perception of Failure

Almost three years after it was announced, OS/2 has a tiny installed base compared to DOS. Although the latest release is fully functional and uses the PM interface, OS/2 suffers from a history of not-quite-complete releases. Once considered a sure thing, the easy acceptance of OS/2 is now in doubt. Given its lackluster reception by developers and users, OS/2 backers are searching for some type of killer application that will differentiate OS/2 from competing operating systems. Microsoft and others think that application will be a database server running on a LAN. Time will tell, however, whether the presence of OS/2 on a server machine will lead to its acceptance on the client machines.

When and if OS/2 develops the range of applications available under DOS, it may finally live up to its billing as the successor to DOS. Until that time, however, moving to OS/2 is not a step to be undertaken by the faint of heart.

The Unix Riddle

Unlike OS/2, Unix has been around for 20 years. It was developed at Bell Labs for a DEC PDP-8 minicomputer. Over the years, it has become the preferred operating system for scientific and engineering computers. It is the dominant operating system on desktop workstations.

Unix has many advantages over DOS. It is both multitasking and multiuser, it has sophisticated memory management capabilities, and software written for one Unix machine is (theoretically) easily portable to other Unix machines.

The problems with Unix stem from its origin. Essentially, it was developed by technical people for technical people. Unix users didn't want to be protected from the complexities of their computers, they wanted to wallow in them. As a result, Unix has developed a well-deserved reputation for providing a decidedly unfriendly operating environment.

Efforts to overcome the unfriendly nature of the Unix interface, which can involve using two or three hundred syntactically obtuse commands such as `grep` and `lp`, have generated some good results and some bad. Two major interfaces, OSF/Motif and Open Look, and minor ones such as the NeXT Workspace Manager, greatly improve on Unix's user friendliness. On the downside, these different interfaces threaten the portability that has been a Unix hallmark.

The Shrink-Wrap Question

Portability is one of Unix's greatest assets. It is also one of the prime restraints against the adoption of Unix outside the technical community. Unix has traditionally offered source code compatibility: Source code developed on one machine could be recompiled on a different machine with few, if any, changes. Outside the technical community, however, users don't want to have to buy and compile source code. They want to buy shrink-wrapped, ready-to-run software. This presents an enormous challenge to Unix developers. The number of different architectures that run Unix is staggering. To develop for only one architecture would be too limiting; to develop for more might be too costly.

So, unlike OS/2, which runs on 80x86 boxes only, a Unix program must be able to run on many architectures. Unix, which is well standardized at the source code level, is terribly fragmented at the

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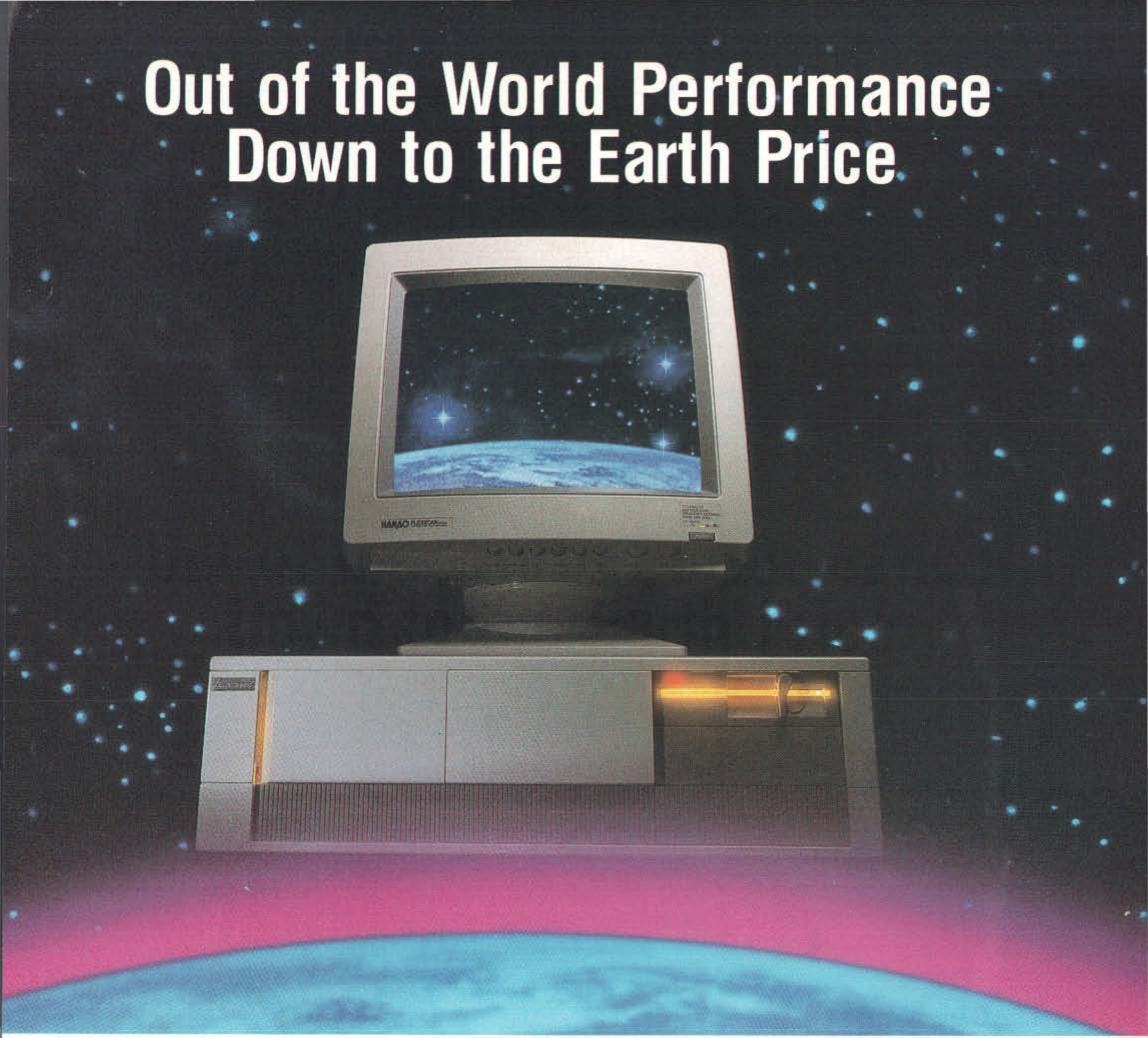

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binary level. Efforts to change this situation are under way, but they either are limited in scope or face enormous technical challenges. For example, Motorola has established the 88Open organization to ensure binary compatibility among programs running on machines that use the Motorola 88000 RISC chip set. On another front, the Open Software Foundation has advanced the Architecture Neutral Distribution Format, a shrink-wrap standard for Unix, whereby a compliant program would self-install on any machine. Success in this area, and consequent success for Unix in the general marketplace, is at least a few years away.

The DOS Response

Although both of its primary challengers have encountered problems in trying to supplant DOS on the desktop, there is no doubt that, in the long run (and with the exception of XTs and laptops), both OS/2 and Unix can let you get more out of your hardware. The point is, can they do it now? With the exception of a few specialized areas, the answer remains no.

This has rekindled interest in DOS at both the developer and user levels. In fact, many of the areas where DOS has been deficient have been the particular focus of developers. In memory management, for example, this interest has led to advancements in expanded memory (see "Expanding the Limits" on page 205) and to the development of extended memory for machines using the 80286 and higher. It has led to the development of multitasking operating systems based on DOS and, finally, to the widespread acceptance of the Windows interface.

DOS Forever?

The popularity of Windows, in fact, may be one of the prime factors obstructing the emergence of both Unix and OS/2. Windows already incorporates many of the features of the more powerful operating environments, and Windows 3.0 (now in the hands of developers) will undoubtedly add many more. The success of the Windows environment has had a negative impact on OS/2 acceptance.

The success of Windows also led to one of the more curious scenes at Fall Comdex last November. Jim Cannavino of IBM and Bill Gates of Microsoft took the stage together to outline the future of Windows and OS/2. In exchange for "recognizing" Windows as a legitimate, entry-level operating environment for its hardware (and apparently for killing off the rumored "PM Lite" project), IBM extracted promises from Gates that Windows would not continue to evolve capabilities that put it into direct competition with OS/2. This curious tableau, with a representative of IBM prescribing the limits of Windows, indicates how seriously IBM considers the challenge that Windows poses to OS/2.

Currently, through expanded and extended memory, multitasking managers, and graphical user interfaces, you can already equip your DOS-based computer with many of the capabilities offered by OS/2 and Unix. Until either of these challengers can offer the range of solutions offered under DOS, you should probably defer any decision to move to another operating system and instead focus on how you can get the most out of what you have. For most people, the practical advantages of staying with DOS currently outweigh the technical advantages of OS/2 or Unix. ■

Bob Ryan is a BYTE technical editor. You can reach him on BIX as "b.ryan."

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Expanding the Limits

If the DOS memory limitations have you thinking about jumping ship, think again

Jeff Holtzman

In 1981, the 1-megabyte address space of the newly introduced IBM PC seemed spacious, indeed. Less than a decade later, however, that same amount of space seems claustrophobic. DOS users search continuously for any nook or cranny into which they can stuff a few K bytes of valuable RAM, to provide a little more breathing room for today's insatiable application programs, network drivers, and TSR programs.

One solution to the memory crunch is to upgrade to OS/2 or Unix, but that can mean buying a new system—and then waiting until the applications you need become available. If you aren't yet ready to commit yourself to either OS/2 or Unix, you should probably stick with DOS for the near term. There are proven ways to get more out of the memory DOS gives you. You simply have to know where to look.

Family Ties

Understanding DOS memory limitations requires examining the memory-addressing capabilities of the Intel family of microprocessors. In rough order of capability, this family consists of the 8088, the 8086, the 80186, the 80286, the 80386SX, the 80386, and the 80486. The 80386SX and 80486 have memory-addressing capabilities that are nearly identical to those of the 80386, so I won't distinguish among them. Other processors I won't discuss specifically are the 8086, which has the same addressing capability as the 8088, and the 80186, which is used primarily as an embedded controller.

The 8088 is paradoxically both the least and the most powerful member of the family. It is the least powerful because it has only 20 address lines, while its younger siblings, the 80286 and the 80386, have 24 and 32 lines, respectively. However, the 8088 is also the most powerful, because the majority of PC software conforms to its limitations.

Because each address line from a processor can assume one of two states, 20 address lines lets you access 2^{20} or 1,048,576 different locations. To the microprocessor, the vast majority of those locations (except some at the very top of memory and some at the very bottom) are functionally identical; it is the operating system that assigns meaning to them. I'll refer to the first 640K bytes in a DOS machine as conventional memory and to the remainder of the first megabyte as upper memory (see figure 1).

The 80286 and the 80386 have more address lines than the 8088, and the locations that they access above 1 megabyte are known as *extended* memory. In general, extended memory is not available to DOS applications. The 80286 and the

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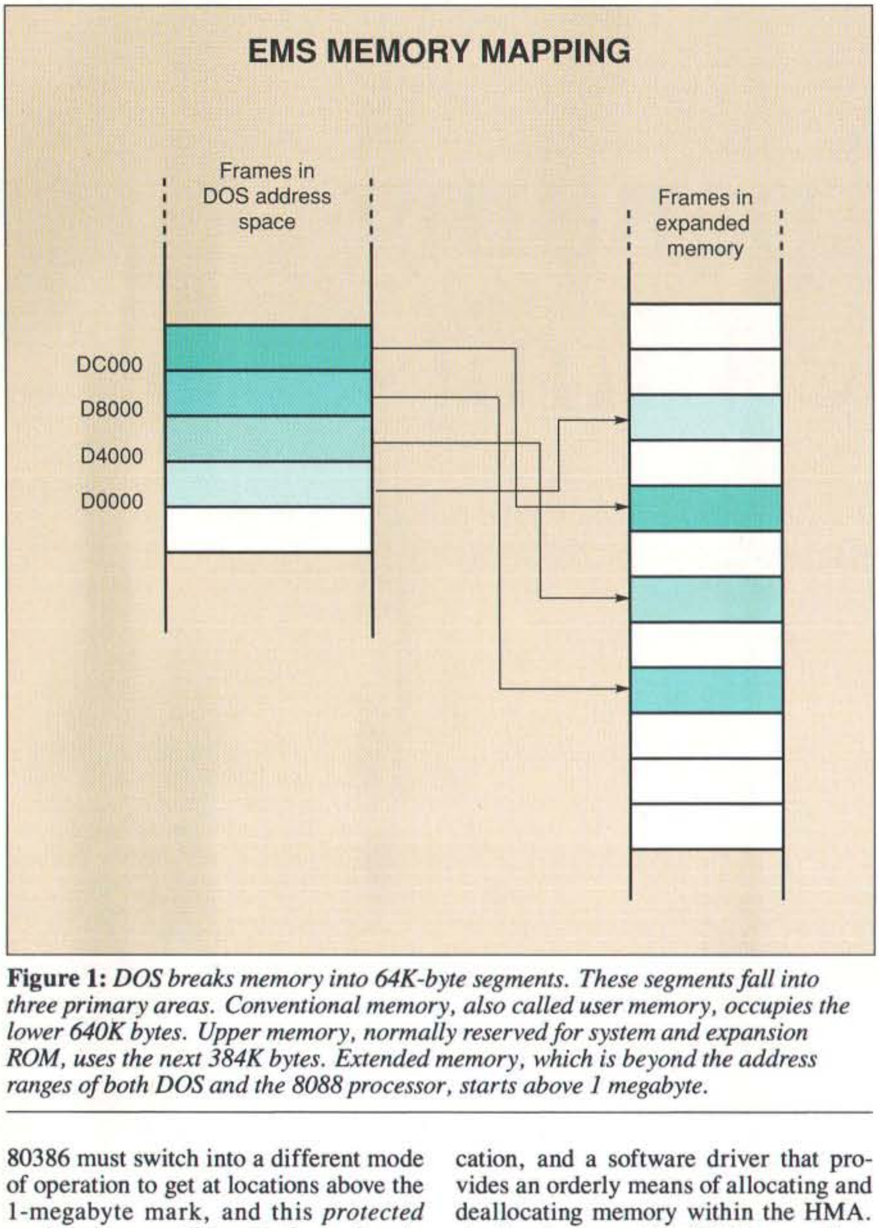


Figure 1: *DOS breaks memory into 64K-byte segments. These segments fall into three primary areas. Conventional memory, also called user memory, occupies the lower 640K bytes. Upper memory, normally reserved for system and expansion ROM, uses the next 384K bytes. Extended memory, which is beyond the address ranges of both DOS and the 8088 processor, starts above 1 megabyte.*

80386 must switch into a different mode of operation to get at locations above the 1-megabyte mark, and this *protected* mode is incompatible with the *real* mode that DOS applications run under.

The 80286 can switch from real mode to protected mode, but not the reverse. To switch to real mode, you must reset the microprocessor, a time-consuming process during which you can lose interrupts. Intel corrected that deficiency with the 80386SX and up.

There is one exception, however, to the rule about accessing extended memory in real mode. Through a quirk of the microprocessor, you can access the first 64K bytes of memory (less 16 bytes) above 1 megabyte without switching into protected mode. That area is known as the high-memory area (HMA); Microsoft has released a specification, called the XMS, or extended memory specification, and a software driver that provides an orderly means of allocating and deallocating memory within the HMA. Applications must be "HMA-aware" to use it, though, and few are. Windows is the only major HMA-aware program released to date.

Memory Block

You can view the first megabyte of DOS memory as consisting of 16 64K-byte segments or memory blocks. The first 10 segments are reserved for the RAM into which you load DOS, device drivers, and application programs. These 10 segments—from address 0000 through address 9FFF—make up conventional memory. (For one approach to getting more from conventional memory, see the text box "The 640K-byte Solution?" on page 208.)

The next two segments (A000 and B000) are reserved for video buffers. The memory on Hercules (and simple MDA) adapters occupies 4K bytes starting at the bottom of the B000 segment; graphics modes can use as much as 32K bytes. The memory on CGA cards starts halfway up the B000 segment (B800); CGA requires either 4K bytes or 32K bytes, depending on the video mode. In text modes, EGA and VGA adapters also use 4K bytes of the B800 segment; their graphics modes can require as much as 128K bytes of memory ranging from A000 through BFFF.

A Hercules (or nongraphics monochrome) system has a 64K-byte gap between itself and the top of DOS memory, and a CGA system has a 96K-byte gap. Several products are available that let you reclaim that area and add it to your contiguous DOS memory pool. With such a product installed, you can end up with more than 640K bytes of free memory after booting.

Hard disk drive and video controller ROMs are often located in the C000 segment. In an XT-compatible system, the hard disk drive's controller ROM is located at C800. In an AT system, this area is free because the hard disk routines are located in the ROM BIOS. EGA and VGA BIOS ROMs live in the bottom of the C000 segment, but some VGA cards also claim space for RAM buffers higher in the C000 segment and elsewhere.

The 128K bytes of space in the D000 and E000 segments are usually available for expanded-memory cards, network-interface cards, and the like. (Officially, the E000 segment is reserved for BIOS extensions, but in many machines, it is free.) And last, the ROM BIOS is located in the F000 segment.

There are two things to note about these segment divisions. First, they're arbitrary; another division could have been used. Hindsight makes it easy to suggest allocations that might have been more efficient, but the current allocations seemed reasonable given the context in which they were made.

Second, not all segments are used in a given machine. This allows the latest generation of hardware and software memory management products to perform their tricks. It also creates possible conflicts and incompatibilities.

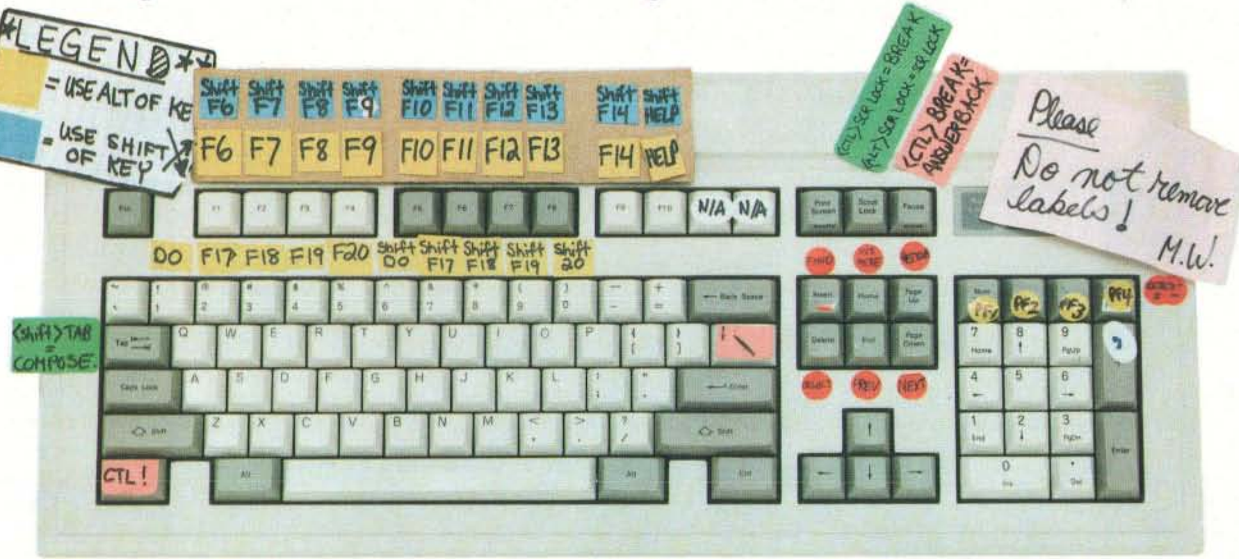
The Expanded PC

There's nothing magical about the 640K-byte DOS user limitation; it's an arbitrary value that seemed viable when it was selected. Back in the late 1970s, advanced CP/M users filled out their

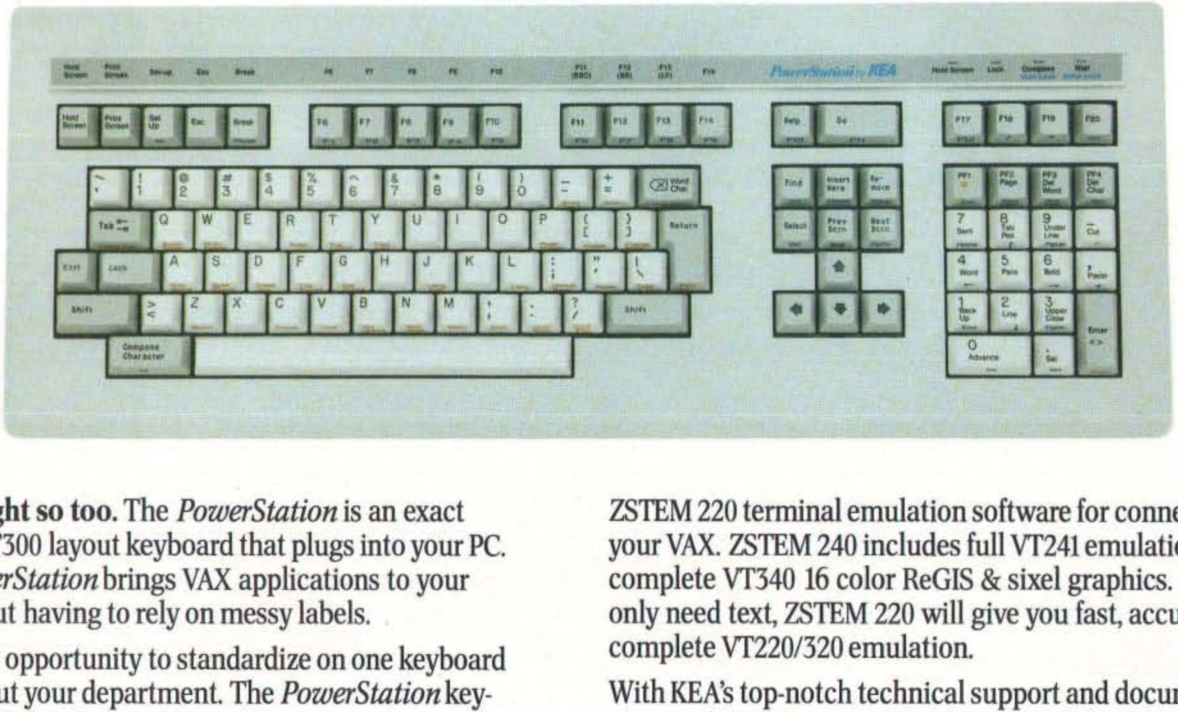
continued

Which terminal emulation keyboard would you rather use?

A.


LEGEND
= USE ALT OF KEY
= USE SHIFT OF KEY
Shift F6 Shift F7 Shift F8 Shift F9 Shift F10 Shift F11 Shift F12 Shift F13 Shift F14 Shift HELP
F6 F7 F8 F9 F10 F11 F12 F13 F14 HELP
N/A N/A
DO F17 F18 F19 F20
Shift DO Shift F17 Shift F18 Shift F19 Shift 20
(CTL) SCR LOCK = BREAK
(ALT) SCR LOCK = SCR LOCK
(CTL) BREAK = ANSWERBACK
Please Do not remove labels! M.W.
(Shift) TAB = COMPOSE
CTL!
FIND
SELECT
PREV
NEXT
PF1 PF2 PF3 PF4

B.



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Circle 148 on Reader Service Card

machines to the maximum of 64K bytes of memory. By the time DOS was introduced a few years later, it allowed 544K bytes at first, and later a staggering 640K bytes of memory—10 times the amount available to CP/M users.

But the PC industry continued to evolve. Software designers started adding features to programs, and users were building ever-larger spreadsheets and the like. Thus, by the mid-1980s, DOS users had essentially run out of memory space. As a consequence, Lotus, Intel, and Microsoft got together and designed a means of adding memory to the PC: what everyone now knows as the Lotus-Intel-Microsoft Expanded Memory Specification (LIM/EMS).

Expanded memory has some advantages over extended memory. For one, you can access it without switching into protected mode. For another, it works with the 8088 processor as well as with later models. That's because expanded memory is in the DOS address space. Although it is not addressed linearly, it is switched into the address space in 16K-byte chunks. On the other hand, relatively few applications know how to use expanded memory, and the hardware to implement it is more complicated (and, hence, more expensive) than the simple decoding circuitry required for extended memory. In addition, you need a special software driver to control the hardware.

An early version of LIM/EMS, 3.2, allowed up to 8 megabytes of memory, which it accessed by switching 16K-byte chunks in and out of a 64K-byte window

The 640K-byte Solution?

Jeffrey Bertolucci

Some people call it "dynamic segment swapping," but undoubtedly the name VROOMM is bound to attract more attention. VROOMM stands for Virtual Real-time Object-Oriented Memory Manager. It is Borland's solution to the limitations that are imposed by DOS's 640K-byte memory cap.

Anyone who has ever gotten an "Out of memory" message while juggling a TSR program and the latest, feature-stuffed word processor or spreadsheet can appreciate VROOMM's purpose: to permit increasingly sophisticated DOS programs to live within the 640K-byte memory limit. According to Borland, the VROOMM technology makes it possible to create programs with more features and better performance for DOS systems.

Tasty Morsels

VROOMM performs its magic by swapping chunks of code (usually 2K bytes to 4K bytes, but sometimes as large as 16K bytes) in and out of memory. These segments, called *objects*, make up the complete application. Using dynamic segment swapping, VROOMM allows a program to swap objects on the fly based on its needs at the moment. If a VROOMM program needs to create a bar graph, for example, it requests the small amount of code needed for that task only, not the entire file for creating all graphs. Also, a VROOMM program can dynamically trade off between code and data in memory, which, according to Borland, is what sets VROOMM apart from traditional overlay systems.

Before VROOMM, the DOS programs that could fit into 640K bytes used segment overlays. With this method, fixed overlay files (often ranging from 30K bytes to more than 100K bytes) are loaded into memory in their entirety when needed (see figure A). Because of the large size of these overlays, there was often little free memory remaining for documents, spreadsheets, or whatever data you were using. And on low-end systems, large overlays could leave you impatiently tapping your keyboard, waiting for the overlay file to load.

Granular Solution

Borland claims that what separates VROOMM from run-of-the-mill segment overlays is the granularity of its code segments. These segments allow a VROOMM program to use less memory, since the only function loaded into memory is the one the user requests. This leaves more space for data.

VROOMM also lets a program swap more or less by itself out to disk as the need for data space grows or shrinks. With this feature, called *object granularity*, VROOMM loads only the parts of a program that are needed.

For example, as you add data to your spreadsheet, VROOMM discards objects (program code) to make room for the additional data. When you call up a different subsystem of the program, VROOMM loads into memory only the objects needed to complete the specific task you requested. Furthermore, the new objects may replace some of the objects that had been loaded previously.

Persistence Makes Perfect

When swapping between disk and memory, VROOMM decides which objects to hang on to by using *persistence algorithms*. These algorithms establish a priority among the objects and attach a persistence value to each object. An object is assigned a value based on its popularity with the program.

VROOMM collects information on a program's habits. It determines which objects are used most often and, when it needs memory space, discards the objects that the program is least likely to use. Whenever the program must load a new object into memory, or whenever more data space is needed, VROOMM discards those objects with the lowest persistence value. VROOMM can also discard more active objects if the program needs more data space.

Persistence prioritization is another advantage VROOMM has over traditional overlay systems. With traditional methods, an overlay is loaded whenever the user requests a subsystem not currently in memory. Standard overlays and persistence don't mix.

Yet another interesting feature of VROOMM is its ability to store discarded objects in expanded memory. This feature is called VROOMM's *object cache*. VROOMM can load objects from expanded memory instead of from disk, which can speed up the performance of a program considerably. Many traditional overlay systems don't use expanded memory to store discarded modules. However, the object-cache feature is of little use to PCs with 640K bytes or less of memory.

DOS Savior or Sales Pitch?

Early reports on the effectiveness of VROOMM have been mostly positive (see "VROOMM Goes the Spreadsheet," October 1989 BYTE). It remains to be seen, however, just how

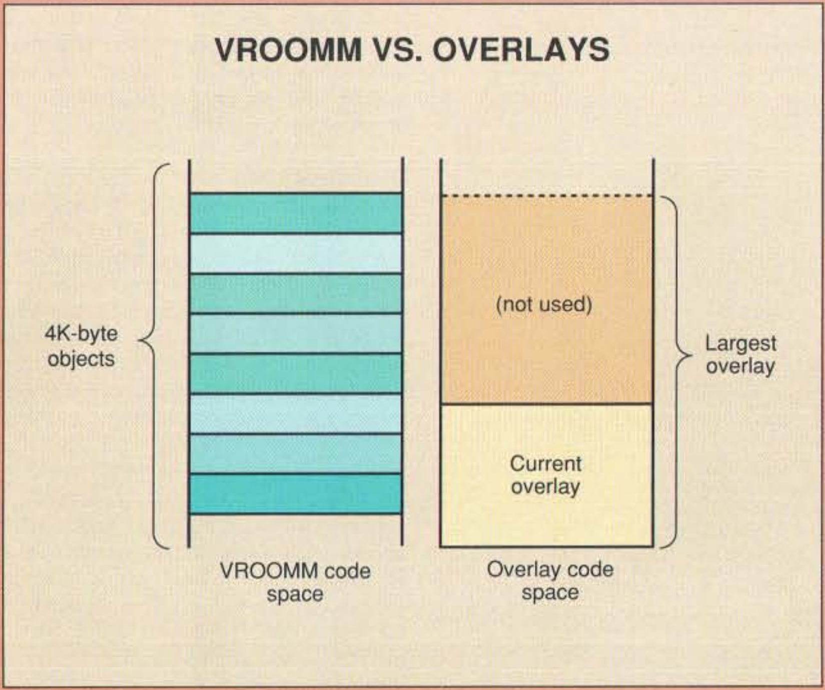


Figure A: *By using finely granulated objects, VROOMM uses all the available physical memory. Overlays waste space whenever any but the largest overlay is in memory.*

well the VROOMM technology will work on smaller systems. Although the slender VROOMM objects do indeed load quickly, they must also be loaded more frequently than overlays, which results in a considerable amount of disk swapping. (Running a VROOMM application from a floppy-disk-based PC would be a test of patience, indeed.)

Thus far, Borland has introduced VROOMM versions of several existing programs (Reflex 2.0 and Quattro Pro, for example). It will be interesting to see if the company chooses to license the VROOMM technology to outside developers or to hang on to what could be its "competitive advantage." If VROOMM can deliver on its promises, the 640K-byte limit of DOS may not seem like such a handicap after all.

Jeffrey Bertolucci is an associate news editor for BYTE in San Francisco. He can be reached on BIX as "bertolucci."

(see figure 2). The window was normally located below the 1-megabyte mark and above the 640K-byte mark. However, several commercial products capitalized on a loophole and located the window in the first 640K bytes. Then they shuttled data to and from it, not via expanded-memory hardware, but by using extended memory or even a hard disk. In both cases, performance and compatibility suffered, and you lost 64K bytes of conventional memory.

Later, AST Research enhanced EMS to let you locate those 16K-byte pages anywhere beneath the 1-megabyte limit; AST's version is known as EEMS, for enhanced EMS. AST's method is more flexible and provides better performance than standard LIM/EMS 3.2 hardware. One of EEMS's biggest advantages is that it allows the quick context-switching needed by multitasking environments.

More recently, LIM/EMS was upgraded to EMS 4.0, which incorporates AST's EEMS enhancements, increases the maximum expanded memory to 32 megabytes, and increases support for multitasking environments.

Watch Your Step

Subtle differences exist among expanded-memory boards. The biggest difference is in so-called EMS 4.0 compatibility. After the 4.0 specification was released, many vendors of 3.2 boards released software upgrades that provided 4.0 compatibility. However, that compatibility is limited in most cases because 3.2 boards don't have the hardware-mapping registers that provide the greatest flexibility. There are even degrees of compatibility among boards with true EMS 4.0 hardware support.

Qualitas, which specializes in DOS memory management software, identified three classes of expanded-memory boards. Type III boards allow a single 64K-byte page frame; they adhere to the LIM/EMS 3.2 specification. Type II boards allow an expanded-memory window larger than 64K bytes, but all the pages in it must be contiguous. Type I boards, which are the most flexible, allow multiple, variable-size, expanded-memory page frames. For example, Qualitas rates AST's RAMpage Plus and Newer Technology's Concentration boards as Type I, and Intel's Above-Board Plus as Type II.

Some EMS 4.0 cards have the ability to make memory available to DOS applications. Teletek's X-Bandit, for example, can "backfill" memory to the 640K-byte mark and beyond, adding 64K bytes or 96K bytes of memory in the video buffer area. (You must be running a monochrome or CGA video adapter to take advantage of that capability.) Software products are available that allow Type I boards to perform the same trick.

In addition, when you have unused, unallocated segments in the upper memory area, a Type I expanded-memory board and proper control software will let you load TSRs (and in some cases, device drivers) into upper memory.

EMS on the Job

You can use expanded memory in various ways. Some programs, notably Lotus 1-2-3, have built-in support for it. EEMS and EMS 4.0 boards are quite useful for running multitasking software. You can also use expanded memory as a disk cache or a RAM disk. In a multitasking environment, the most efficient way to use an expanded-memory board is to remove as much memory as possible from the system board and let the expanded-memory board fill in the gap. Then,

continued

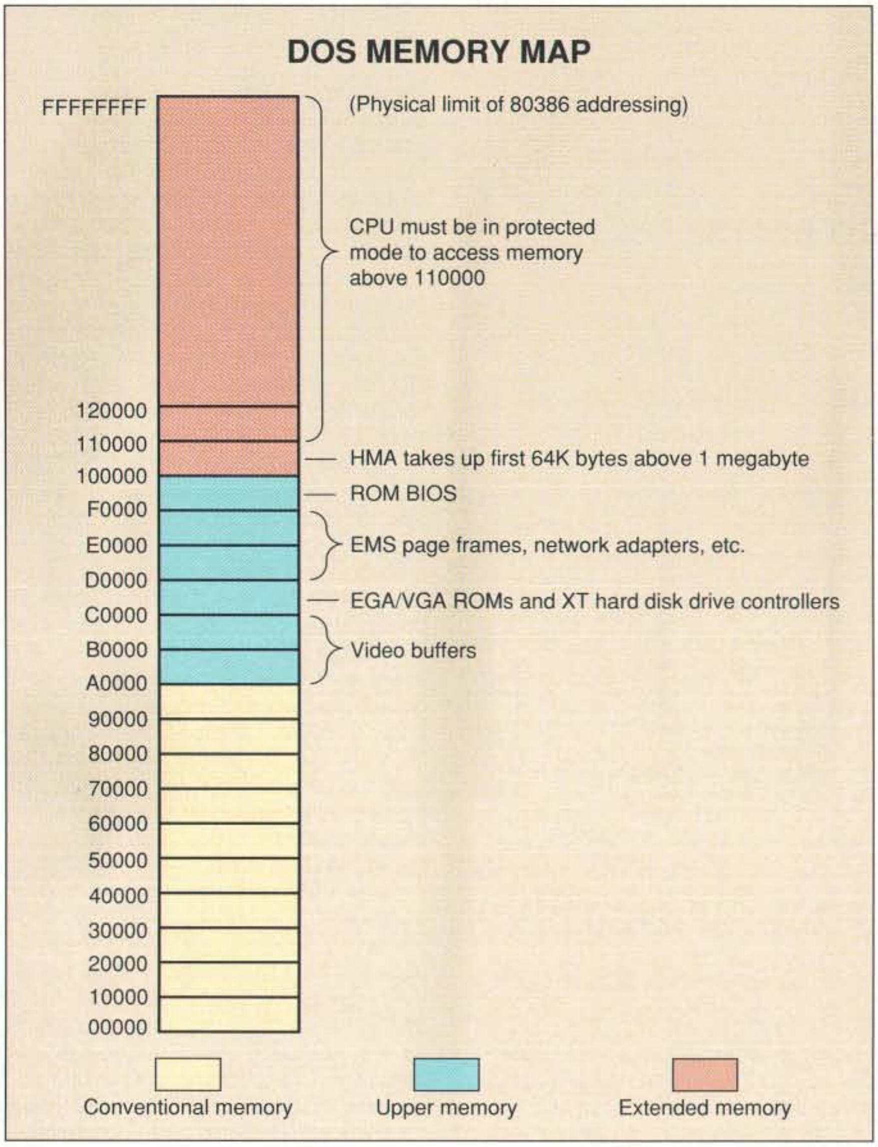

DOS MEMORY MAP
FFFFFFFF
(Physical limit of 80386 addressing)
CPU must be in protected mode to access memory above 110000
120000
110000
HMA takes up first 64K bytes above 1 megabyte
100000
ROM BIOS
F0000
E0000
EMS page frames, network adapters, etc.
D0000
EGA/VGA ROMs and XT hard disk drive controllers
C0000
B0000
Video buffers
A0000
90000
80000
70000
60000
50000
40000
30000
20000
10000
00000
Conventional memory
Upper memory
Extended memory

Figure 2: *Under expanded memory, a number of 16K-byte frames from the expanded-memory store are available to the microprocessor in the normal DOS address range. The frames can come from any part of expanded memory. Under LIM/EMS 3.2 (shown here), the frames must be contiguous in the DOS address space and are limited to four. EMS 4.0 can store up to 64 frames anywhere below the 1-megabyte limit, but it requires a four-frame window to ensure backward compatibility.*

when a multitasking environment switches tasks, it can swap entire 16K-byte chunks of memory with just a few I/O instructions, rather than copying memory, byte by byte, from an expanded-memory window in upper memory.

It is important to understand that, although expanded memory solved a problem plaguing many users, it introduced some new problems, because the microprocessor does not control the memory hardware directly, and the software driver that controls the hardware isn't part of the operating system. Thus, there is room for variation among vendors.

The first problem is that one manufacturer's expanded-memory driver won't work on another's expanded-memory board. So you can't mix boards from different manufacturers in the same system.

The second problem is that boards have widely varying amounts of flexibility in their configurations, requiring several different types of code corresponding to different expanded-memory levels and board types. Ideally, you wouldn't have to worry about those details: The operating system would do it. (Sophisticated operating systems, such as Unix and OS/2, handle such details. That's one of their greatest appeals.)

The third and biggest problem is the one you face when you try to use expanded memory. To install and use an EMS 4.0 board correctly, you must understand an awful lot about how your system and expansion boards use the upper segments and I/O ports.

Boardless EMS

As expanded-memory boards caught on, the major chip vendors got involved at the system level. For example, in 1988, Chips & Technologies introduced the NEAT (for new enhanced AT) chip set, a set of four VLSI ICs that, among other things, have built-in LIM/EMS 3.2 support (or EMS 4.0 support with the addition of a special Mapper chip).

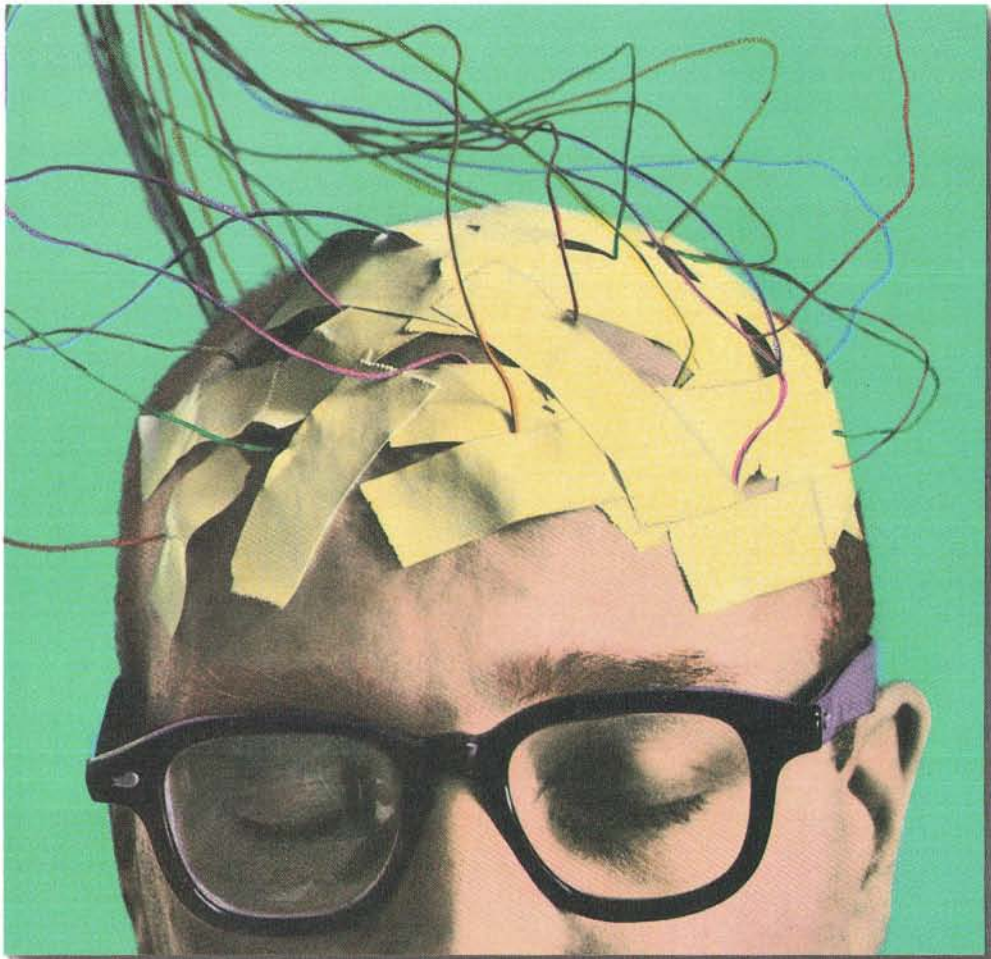
NEAT system boards can also map memory from the extended region to the upper region. The primary purpose of this type of mapping is to enable ROM shadowing (in which the contents of slow ROMs are copied to faster RAMs and executed from there). But at least one software product, Move'em from Qualitas, uses the mapping capability to increase usable DOS memory. (A $35 shareware program called CTMAP performs the same function on 80386 system boards with 82C302 or 82C307 DRAM controllers made by Chips & Technologies. It is posted on BIX as CTMAP091.ZIP.) [Editor's note: *CTMAP is available in a variety of formats. See page 5 for more details.*]

The 80386 microprocessor contains special hardware that can map any 4K-byte page of physical memory (above or below the 1-megabyte mark) to any 4K-byte slot in logical memory (i.e., to a given DOS environment). Under control of the appropriate software, an 80386 can thereby provide complete hardware-level EMS 4.0 compatibility, but without the added expense of an expanded-memory card. Several vendors sell products that take advantage of this feature, including Quarterdeck (QEMM) and Qualitas (386MAX Professional).

The 80286 doesn't have the flexible memory-handling capabilities of the 80386. Retrofitting a pre-existing 80286 for flexible memory management requires a Type I EMS 4.0 card or a device such as the All ChargeCard from All Computers. You install the ACC between the 80286 CPU itself and the system board. Coupled with a software driver, it

continued

Until now there was only one way to integrate C and Assembler.



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gives the 80286 most of the memory-mapping capabilities of the 80386. Specifically, you get a fully hardware-compatible EMS 4.0 environment that can provide efficient context switching and efficient access to memory above the 1-megabyte mark. The ACC also includes software to load DOS programs and device drivers into the upper 384K bytes.

However, being a retrofit, the ACC has a few problems of its own. For one, it does not reboot properly via a hardware-reset switch, so it may not be appropriate in a development environment. In addition, the ACC does not handle DMA operations properly, so some tape backup units, for example, don't work with the ACC software installed.

The ACC is also physically difficult to install, and it's expensive (about $400, plus another $100 for an adapter kit required for systems without a PGA-type CPU socket). By contrast, in late 1989, you could buy a replacement 80386SX system board for somewhat less than the cost of the ACC, or a full 80386 board for slightly more.

All Computers also has a version of the ACC for 8088-based systems.

Let's Get Physical

Given the history of DOS and expanded memory, let's look at various scenarios and see how you can get more physical memory for a DOS system.

The best possible setup if you want to maximize conventional memory is an 80386 system with several megabytes of memory and an 80386 memory manager. However, since you can't simply pull out an 8088 or 80286 board and replace it with an 80386 board, you need an 80386 (or 80386SX) coprocessor board to have such a system on an XT or AT.

Short of a coprocessor or motherboard swap, the options for an AT system are the ACC or an expanded-memory board. The ACC is an impressive technical achievement, but it has a few problems, and it's priced quite close to 80386 system boards. Most people will opt for an expanded-memory board.

Unless you're sure you'll be satisfied with LIM/EMS 3.2 compatibility, however, steer clear of the bargain-basement boards. Most have LIM/EMS 3.2 hardware and an EMS 4.0 emulation driver that can't do the kinds of tricks I've talked about. Even true 4.0 boards from well-known vendors have varying capabilities, so check the specifications.

One good choice is the Teletek X-Bandit. It's flexible, and it includes its own upper-memory program loader (you would have to buy this separately with most boards). One drawback is that the X-Bandit can hold only a maximum of 2 megabytes of RAM; however, you can have more than one X-Bandit in a system.

In an XT environment, the choices are similar to those available on the AT. An accelerator card such as SOTA Technology's 386si gives you an 80386SX running at 16 MHz. However, because the XT's expansion bus is limited to 20 address bits, the only way to add memory that an 80386 memory manager can control is to add it to the card itself. If you plan to stay with the XT, an EMS 4.0 card and an upper-memory manager probably constitute the best upgrade path. Teletek, for example, makes an 8-bit version of the X-Bandit.

Be Prepared

Once you have mappable-memory hardware in your machine, you have to put it to work. Before jumping into memory management software, however, you can take a few steps that will make running your memory manager easier.

When using any of the memory managers I'll discuss, you should configure your expansion cards—video adapters, network interfaces, and so on—to use a single contiguous block of memory, if possible. That lets you allocate a single block in which to load DOS programs and device drivers. A single 64K-byte block of contiguous memory is more valuable than four separate 16K-byte chunks, because a smaller chunk severely limits the maximum size of the program you can load.

When allocating upper memory, you have to balance the number of expanded-memory page frames against the amount of memory that DOS can address directly. In general, you should allocate just as much upper memory as you need to load the necessities, and set the remainder up as expanded-memory page frames. Try to find out how your primary application uses expanded memory; older programs, such as earlier versions of Lotus 1-2-3, won't take advantage of more than four expanded-memory pages; newer ones, such as Windows, will.

Also, choose your video adapter with care; if you can get by without EGA or VGA, do so. A Hercules monochrome adapter lets you add an extra 64K bytes to contiguous DOS memory, and that alone improves the performance of many applications (including Windows) greatly.

The Driving Force

All DOS memory management hardware depends on software. Some programs,

continued

Advertisement

CHOOSING A MULTI-USER SYSTEM OR LOCAL AREA NETWORK

by Rod Roark

A common decision managers make when automating a business is whether to install a multiuser operating system or a LAN. Makin the right choice involves evaluating the way the business operates, the daily tasks employee perform, and existing resources.

In general, multiuser systems are ideal for communication within intensely interactive workgroups, such as those found in specialize departments like accounting or sales. LANs were once the only way PC users could share information, and today are an ideal way to tie multiuser workgroups together.

Compared to LANs, multiuser systems are economical, provide faster disk access, and are easier to install, configure and maintain. They also work well when several people need to share the same high-cost peripherals, such as laser printers, check printers and plotters.

The daily demand users will put on the system is a critical factor to consider. CPU-intensive activities, such as CAD/CAM, work well in a distributed processing (LAN) environment, while disk-intensive activities, such as data entry, are well-suited to a shared processing (multiuser) system. Most businesses with more than a handful of employees are best served by a hybrid system of several multiuser workgroups tied together by a LAN.

The company's resources, including budget, current installed hardware and software, and technically-minded people, cannot be overlooked in determining the optimal system.

If the company has an existing base of PCs, but needs a way to share information, printers and other peripherals, a LAN is a good choice. If the company has more users than PCs, and needs a way to provide more processing ability inexpensively, a multiuser solution is optimal. Some multiuser operating system companies, such as The Software Link, provide options that incorporate existing XT- and PC-style computers into a multiuser system.

Because multiuser systems, particularly DOS-compatible ones, are easier to use and maintain than LANs, it is usually unnecessary for a company to hire a network administrator. Once a local consultant or dealer configures and installs the initial system, most companies are able to handle daily maintenance.

Consulting a local specialist or dealer with experience in multiuser systems and LANs is a good way to determine the best option.

Rod Roark is co-founder of The Software Link, a multiuser operating system and local area network software development company founded in 1983. Its core products, PC-MOS and LANLink 5X, have more than 100,000 users worldwide.

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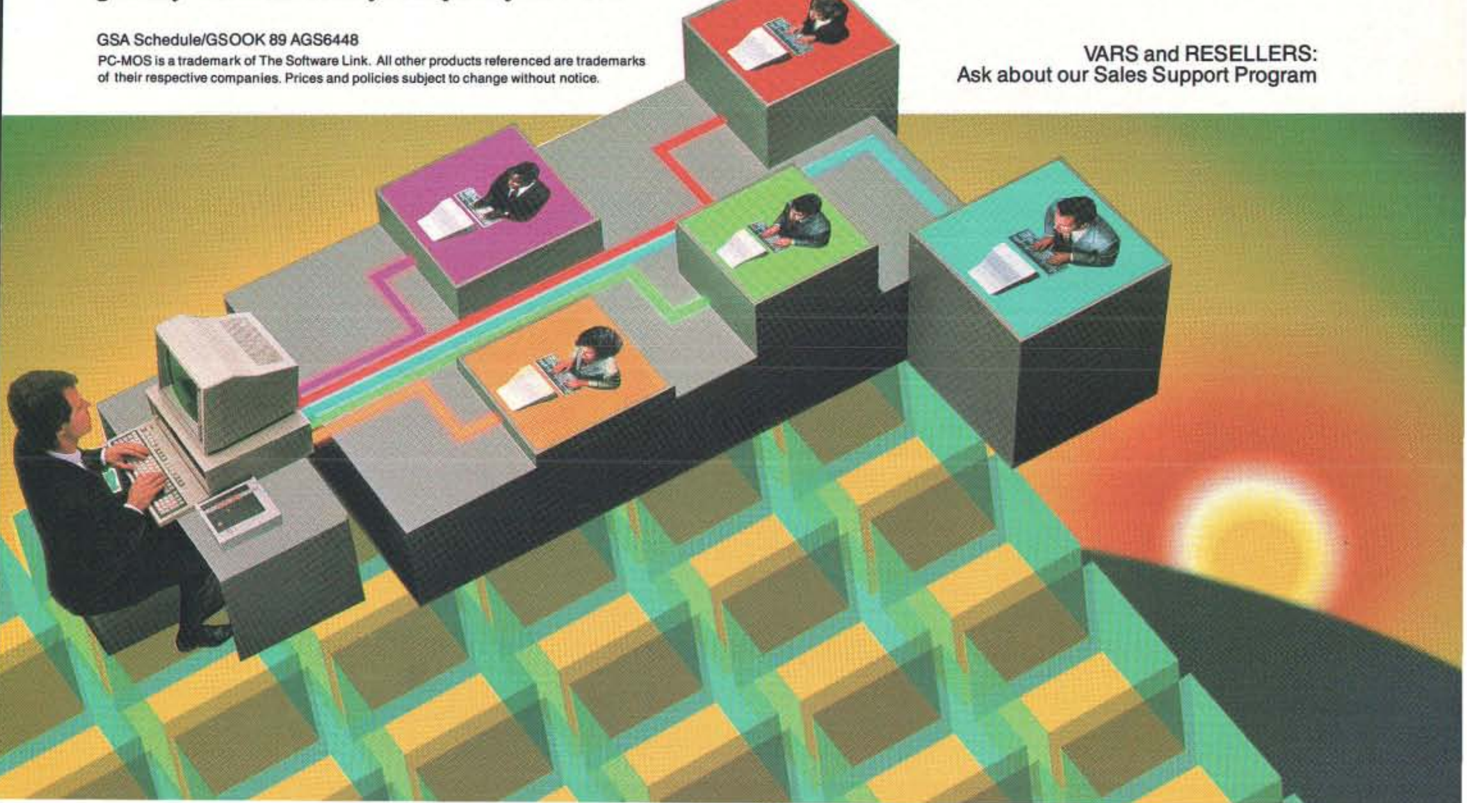

such as Lotus 1-2-3, use expanded memory automatically when it is present. Specialized memory managers provide other functions.

In an 80386 environment, 386MAX Professional provides full EMS 4.0 emulation and the ability to load DOS programs, TSR programs, and device drivers into upper memory. It also gives you a powerful environment for running some multitasking software. It is, however, incompatible with software that needs to run in protected mode (e.g., Windows/386). I boot my 80386 system with one CONFIG.SYS file that loads 386MAX for use in DOS and another (without 386MAX) for use in Windows.

In AT or XT environments with true EMS 4.0 memory, Move'em provides several of the features of 386MAX. Move'em is unique in that it can help you optimize the order in which you load programs into upper memory. In fact, about 90 percent of the source code in both 386MAX and Move'em is identical. (Quarterdeck Office Systems has a similar product called QRAM.)

Hard Cache

Many office PCs are 80286s with 1 megabyte of memory. The extra 384K bytes is mapped as extended memory into the address space above 1 megabyte and often goes unused. A simple way of increasing overall system performance is to use that memory as a disk cache. SMARTDRV.SYS, which comes with Windows, will do this. It is reliable, easy to set up, and conservative in its use of low memory. VCache from Golden Bow Systems is another caching utility that uses upper extended memory on an AT.

A program called Memory Master plays a sneaky trick for EGA and VGA users: It gives the first 96K bytes of upper DOS memory (i.e., the memory actually on the video adapter) to DOS, allowing you to run text-mode-only programs. This is a kludge, but it could be useful. However, aside from possible software incompatibilities, be aware that video memory is typically five to 10 times slower than regular RAM.

Memory Master comes with a driver that allows you to map EMS 4.0 memory into the upper segments and load TSRs there, as well as a number of utilities for swapping specific TSRs (e.g., SideKick and Gofer) in and out of main memory, reducing main memory usage to about 10K bytes. Programs like Switch-It and Dr. Switch provide similar swapping capabilities. (For further information on managing TSRs, see "Easing the RAM-Cram Blues" on page 227.)

An Old Friend

Gaining access to more than 640K bytes of memory on a DOS system is possible. In fact, with some solutions, you can use several megabytes. It's also possible to use upper DOS memory to load device drivers and TSRs and to create a window into expanded memory, but it isn't easy. You have to work at it.

The solution that many vendors are encouraging is to solve all those problems by upgrading to OS/2 or Unix. That's fine if you want to buy a new system or upgrade your old one and you have the time to wait for applications software. But the hardware and software exist to get more mileage out of your current DOS system. ■

Jeff Holtzman is a freelance writer and computer consultant in Ann Arbor, Michigan. You can contact him on BIX as "jholtzman."

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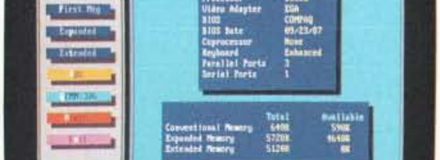
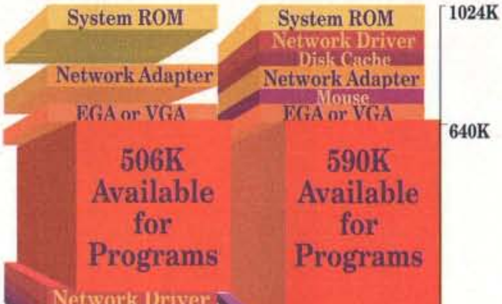


```
COMPAQ Deskpro 386/20
Processor          80386
Video Adapter      EGA
BIOS               COMPAQ
BIOS Date          09/23/87
Coprocessor        None
Keyboard           Enhanced
Parallel Ports     3
Serial Ports       1

                      Total      Available
Conventional Memory    640K        590K
Expanded Memory       5728K       4640K
Extended Memory       5120K          0K
```

Manifest shows you what's 'under the hood' of your PC.



Your current memory is full of holes. Our tools can fill blocks of unused addresses between 640K and 1024K to free up memory your programs can use.

Manifest shows you the contents of AUTOEXEC.BAT and CONFIG.SYS files. That can be a big help when diagnosing problems. Manifest tells you all about your hardware, too—from your cpu type to what boards you have installed. Manifest even tests memory speed.

And it runs benchmark tests on expanded memory boards so you can make informed buying decisions.

You won't need a PhD to understand what you're doing. Manifest has an interactive 'manual' that tells you how to use the program and what benefits you'll get.

And unlike a lot of hot new software, Manifest works on virtually any PC: 8088, 8086, 80286 or 80386. It's a productivity breakthrough from the memory experts at Quarterdeck.

Introducing QRAM—the Quarterdeck memory optimizer

End RAM cram in your 8088, 8086 or 80286 PC once and for all. QRAM (pronounced cram), is a package of utilities that gives you unprecedented control over memory, letting you set up your memory the way it will work best for you.

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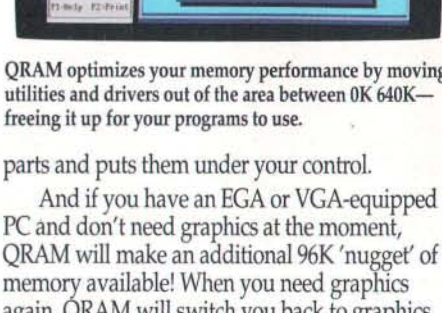
And, like all Quarterdeck memory products QRAM is compatible with the Microsoft XMS specification used by Windows 286, V. 2.x.

If your PC has 'shadow RAM,' there's even more gold in your PC. QRAM finds the unused parts and puts them under your control.



```
Memory Area   Size   Description
0879 - 0C4C   3.3K   COMMAND
0C4D - 0C50   0.1K   [Available]
0C51 - 0C5B   0.2K   COMMAND Environment
0C5C - 9FFF   590K   [Available]
───Conventional memory ends at 640K───
B000 - B006   0.1K   IPX Environment
B007 - B08C   2.0K   FILES
B08D - B4AF    15K   IPX
B4B0 - B7FF    13K   [Available]
C400 - C533   4.8K   CACHE
C534 - C536   0.1K   MOUSE Environment
C538 - C66A   4.8K   BUFFERS
C66B - C7E1   5.9K   MOUSE
C7E2 - C7E8   0.1K   NET3 Environment
C7E9 - D131    37K   NET3
D132 - DFFF    59K   [Available]
```

QRAM optimizes your memory performance by moving utilities and drivers out of the area between 0K 640K—freeing it up for your programs to use.

And if you have an EGA or VGA-equipped PC and don't need graphics at the moment, QRAM will make an additional 96K 'nugget' of memory available! When you need graphics again, QRAM will switch you back to graphics mode! Think how helpful that will be for those big dBASE files.

QRAM can't work miracles, but if there's memory available anywhere, QRAM lets you use it to increase your PCs speed and performance.

QRAM is available bundled with Manifest for just a few dollars more than Manifest alone.

Manifest and QRAM—two more examples of Quarterdeck's commitment to mining the most productivity out of the PC and software you own today.

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Introducing QEMM 50/60 Version5.0

MM (Quarterdeck Expanded Memory nager) 50/60 is the gold standard in memory nagement for the IBM PS/2™ series 50 and 60. orks with IBM's Memory Expansion Option, panded Memory Adapter/A and compatible mory boards.

It supports all three specifications for panded memory: EMS 4.0, EMS 3.2 and EEMS mory so you can run all expanded memory grams.

And it also works with Microsoft's XMS cification, in case you want to use Windows.

QEMM lets you use memory locations ween 640K and 1024K to run TSRs, mouse d network drivers, DOS resources and MCA aptors. That means you can gain up to 130K of mory space below 640K for your programs.

Best of all, QEMM is designed to be easy to —even for those new to the PC. Just install it d type 'optimize,' and it looks at ur AUTOEXEC.BAT and NFIG.SYS files and loads atever it can in high mory. Automatically.

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ystem Requirements

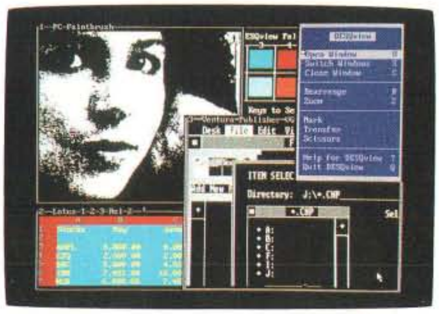
anifest: 8088, 8086, 80286 80386 and i486 PCs & S/2s

RAM: 8088, 8086, 80286 PCs. Use of high emory is only available when PC has EMS 4 or EMS expanded memory or Chips & Technologies hadow RAM.

EMM 50/60: 80286-based PS/2s and compatibles ith IBM PS/2 80286 Memory Expansion Option, BM PS/2 80286 Expanded Memory Adapter/A or ompatible.

EMM-386: 80386-based PCs and PS/2s and PCs ith 80386 add-in boards.

demarks: IBM, PS/2: IBM Corporation; PC Tools: Central Point Software; 80386, 6: Intel Corporation, Chips and Technologies: Chips and Technologies



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Introducing QEMM 386 Version5.0

QEMM 386 can expand the memory of all 386-based computers, including PCs with 80386 upgrade boards. It makes your memory compatible with EMS 4.0, EMS 3.2 and EEMS memory without having to add special hardware. It's compatible with protected-mode programs (like 1-2-3 Release 3, IBM Interleaf and Paradox 386) using DOS extenders compatible with the Quarterdeck/Pharlap VCPI spec.

QEMM also works with Microsoft's XMS spec to extend memory for Windows users.

QEMM gives you maximum control over your memory between 640K-1024K. It can find unused memory nuggets as small as 4K and use them to free up room for programs to use.

QEMM 386 even monitors how your programs use memory while they're running. Then it shows you where there's additional memory you can use. It even measures which parts of your memory are fastest and 'decides' how to use them for better performance. In action, it's easy and fun—almost like having an *artificial intelligence* program to help tune up your PC.

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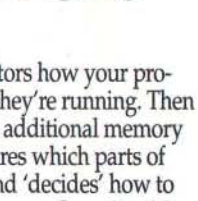
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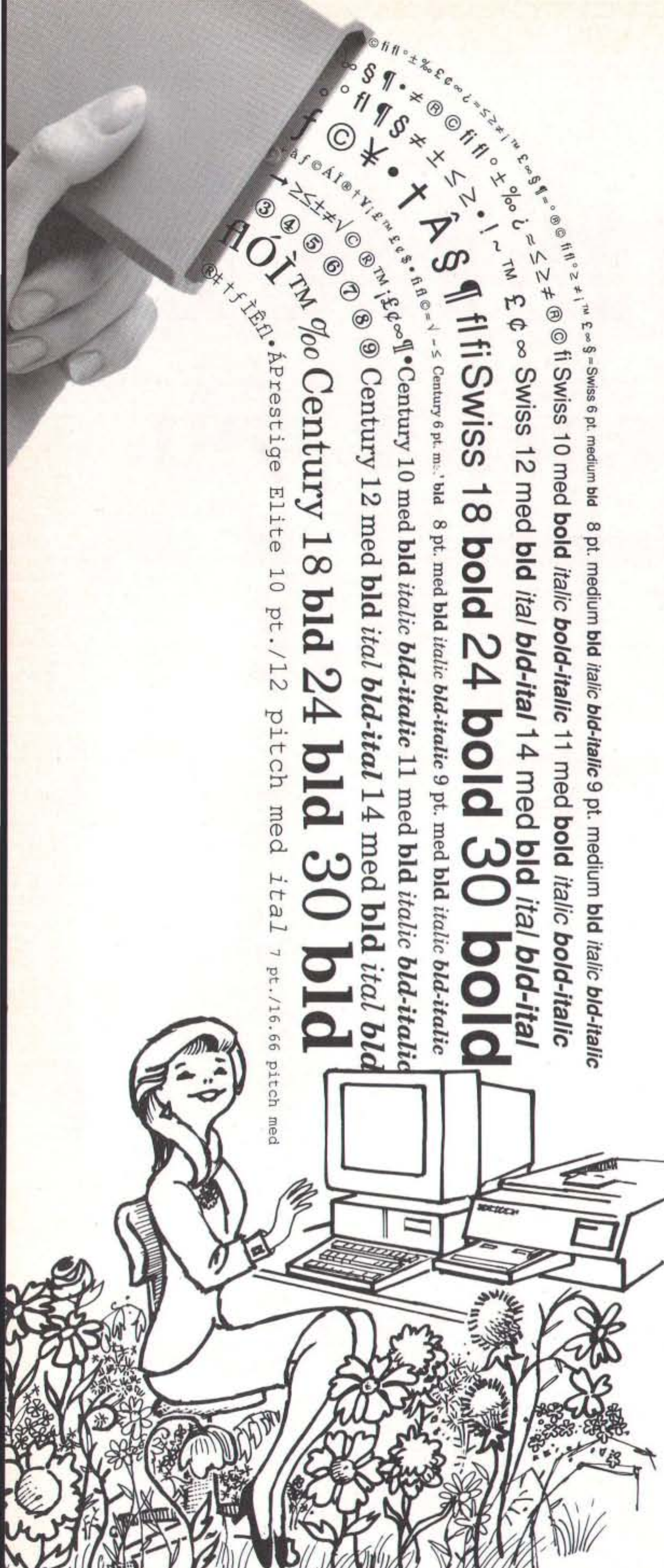
Swiss 6 pt. medium bld 8 pt. medium bld italic bld-italic 9 pt. medium bld italic bld-italic
Swiss 10 med bold italic bold-italic 11 med bold italic bold-italic
Swiss 12 med bld ital bld-ital 14 med bld ital bld-ital
Swiss 18 bold 24 bold 30 bold
Century 6 pt. m... bld 8 pt. med bld italic bld-italic 9 pt. med bld italic bld-italic
Century 10 med bld italic bld-italic 11 med bld italic bld-italic
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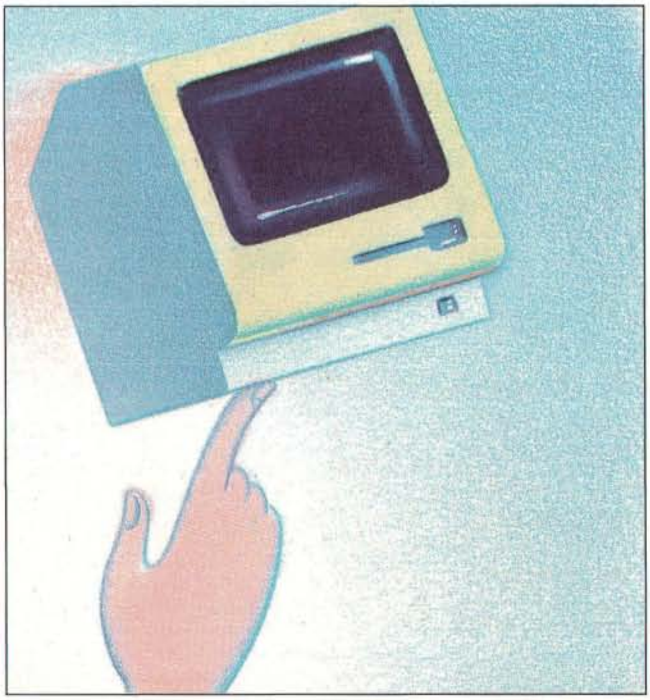
Mac at the Minimum

You and your Mac can accomplish at lot with just 1 megabyte of memory

Tom Thompson



Use a Mac with only 1 megabyte of RAM? You're kidding, right? Look at all those color graphics applications that must need megabytes of RAM just for themselves, on top of what the Mac's graphical user interface needs. Everybody knows GUIs are memory-intensive. Why, MultiFinder alone needs at least 2 megabytes of RAM. Why are Macs shipped with just 1 megabyte of memory, anyway?

The misconception of large memory requirements occurs because of what the Mac does best: graphics and color, which tend to require copious amounts of RAM. Color painting and drawing applications produce results with an immediate, attention-grabbing impact, unlike the output of a spreadsheet or word processor. Accounting and word processing are not as splashy as artwork, nor do they demand tons of RAM to get the job done. This is the main reason the standard RAM configuration for a Mac is still 1 megabyte.

So, to answer the question: Yes, you can use a 1-megabyte Mac. I'll show you what you can do (and what you can't) with 1 megabyte and explore several realistic configurations to give you ideas on how to do it. Wherever possible, I'll supply hints to help you make the best use of available RAM.

A Mac and Its Memory

Before you can figure out how you're going to work within the confines of a megabyte, you need to know which actions on the Mac use memory and which actions free it. As you might expect, not all the RAM is available for your application. Part of it goes to system overhead for interrupt vectors, device drivers, buffers, and other data structures (see figure 1). I'll examine memory, from the lowest addresses (low memory) to the highest (high memory), to show you how it's used.

Low memory starts with *exception vectors*. They contain addresses that point to routines for dealing with traps (microprocessor exceptions), such as a bus error, divide-by-zero, or an illegal instruction. The Mac OS calls and Toolbox routines are implemented as an exception (the line A emulator trap) whose vector points to a trap-handler routine. This routine redirects the microprocessor's execution to the appropriate operating-system or ROM code. Also in low memory are the *system global variables*, which are used to maintain the Mac and its operating system. For example, one global contains a pointer to the first element in the device list, another points to AppleTalk variables, and another holds the address of the stack base.

Next comes the *system heap*. It holds

continued

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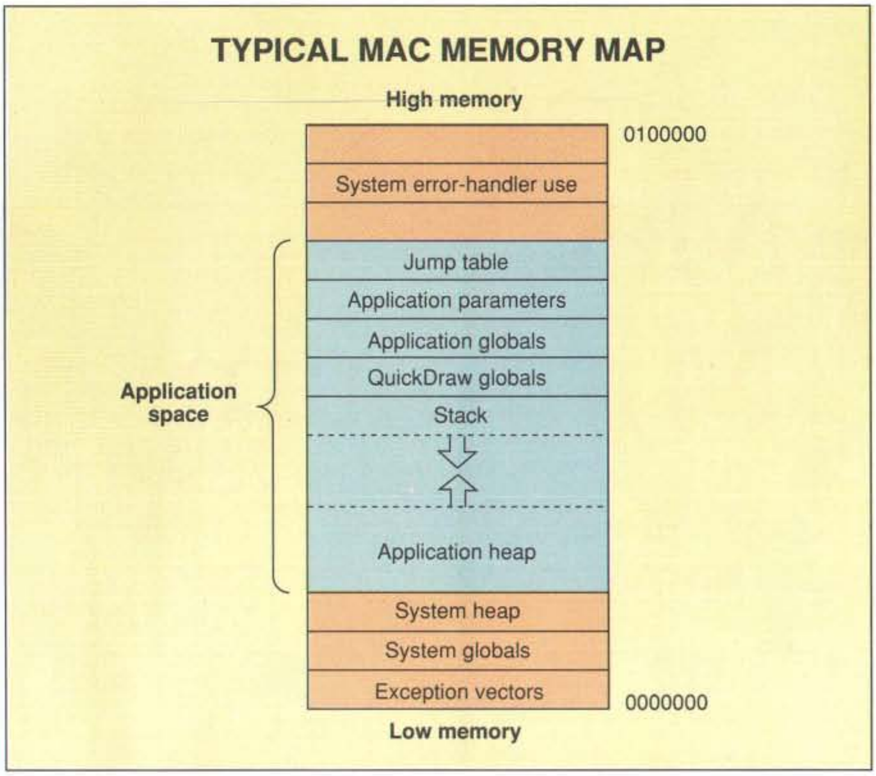


Figure 1: *A generic memory map for Macintosh computers. Your application runs in the application space. The Mac Plus and SE screens and sound buffers are located in high memory. The QuickDraw globals and jump table are used to manage the operation of the application and maintain its graphical user interface.*

the system resources, such as device drivers. It also contains the patch code and initalization resources (INITs) that fix bugs or add enhancements to the system software. The size of the system heap is fixed. It starts at an initial predefined size. It can expand at boot time to hold additional resources (such as INITs) loaded into it.

Above the system heap is the *application space*. Outside the application space the contents of memory are usually static, because code, such as device drivers, must be available to the system as it goes about its duties. But the contents of the application space change each time you load a new application and as the application runs.

The application stack grows from the top of the application space. At the bottom of this space is the *application heap*, where an application's code and resources are loaded. As the application runs, more resources load, and it makes requests for additional memory for temporary variables or buffers. Both of these actions allocate extra memory on the heap, which grows toward higher memory as the stack grows downward.

Ideally, the stack and the heap never meet. There are safeguards to prevent the heap from colliding with the stack (the system global `ApplLimit` defines the upper limit to the heap's growth), but none to prevent the stack from smashing into the heap. If you get a bomb box with an ID of 28, that's what happened.

When the Mac starts up, the Finder is inside the application space, displaying the Desktop and carrying out file operations. When you double-click on a document, the application that created the document replaces the Finder in the application space.

The system error handler uses some of the high memory. The error handler is the routine that gives you the bomb box when things are seriously out of whack. High memory is also used as the RAM cache if it is switched on. This is one area of memory outside the application space that changes constantly. Certain older INITs also install themselves in this memory region.

Finally, some of the high memory is allocated to specialized buffers, depending on the specific Mac hardware you have installed. For example, both the Mac Plus and the SE use about 22K bytes of RAM to serve as a screen buffer. (In the IIci, the on-board video screen buffer is located in low memory.) The SE/30 and the Portable have their own dedicated video RAM and thus don't require a screen buffer in RAM, while the Mac II's screen buffer exists on a NuBus video board. The Plus and SE also have a sound buffer located in this buffer region. The other Macs use the Apple Sound Chip (ASC), so they don't need RAM for a sound buffer.

So you actually have something less than a megabyte of RAM for your application to begin with. How much exactly? It depends on the Mac, since various patches and buffers on certain Macs use different amounts of memory. To give you a rough idea of how much RAM you're actually left with, I installed the minimum System 6.0.4 configuration on various Macs. I used Symantec's SUM II Tools to report on the size of the application space. The results are in figure 2.

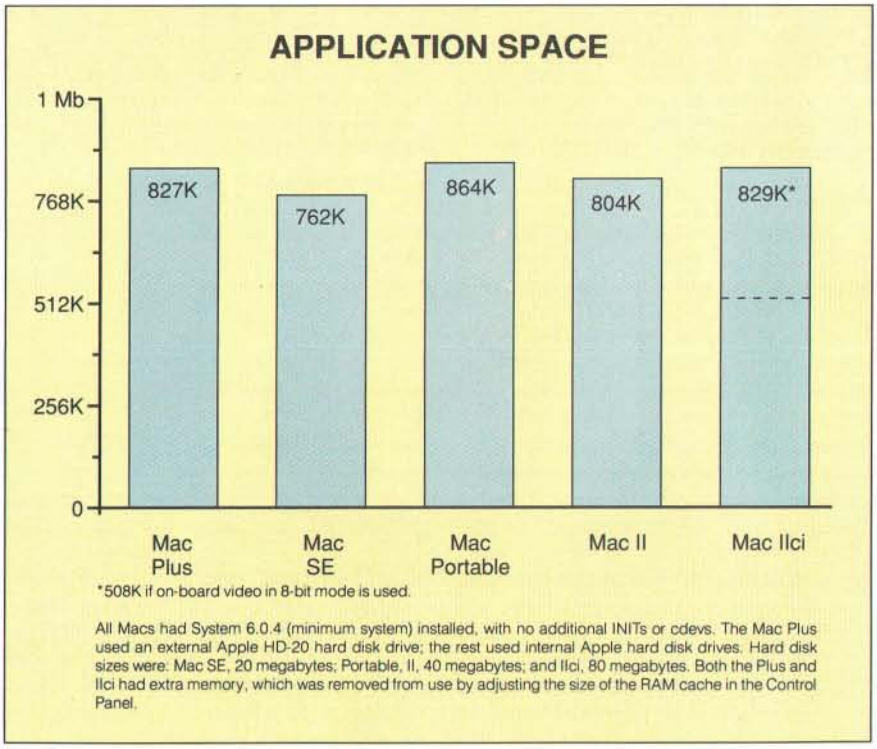
The Mac Portable has the most memory to spare, and the SE the least. The Portable's RAM surplus is due to its hardware video memory, the ASC, and the fact that its ROMs incorporate the latest bug fixes, which reduce the patch code in the system heap.

The IIci benefits for the same reason: Its ROMs incorporate all the bug fixes accumulated over time from earlier Mac IIs. However, on the IIci, the computer's display uses a NuBus video board. If you use its on-board video instead, the application space dwindles to 508K bytes, because 320K bytes is allocated in RAM for an 8-bit screen buffer.

Sizing It to Fit

Now that you know how much memory you've got, you need to find out what you can run within the application space. The quickest way to determine what's going to fit is to list what you *can't* use. You can eliminate MultiFinder, since it requires at least 2 megabytes of RAM. It needs the additional memory because of new data structures maintained by MultiFinder and because a copy of the Finder—which uses 160K bytes of RAM—remains in memory. (The Finder hangs around to manage the Desktop.)

Mac II owners can strike 32-Bit QuickDraw from the list as well. The stated RAM minimum for 32-Bit QuickDraw is 2 megabytes. There are two reasons for this limit. First, since 32-Bit QuickDraw was introduced long after the Mac II was, it isn't part of the Mac II ROMs. (The IIci's ROMs are up to date, however, and have 32-Bit QuickDraw in firmware.) Therefore, 32-Bit QuickDraw is "added" to the Mac as a RAM



*508K if on-board video in 8-bit mode is used.

All Macs had System 6.0.4 (minimum system) installed, with no additional INITs or cdevs. The Mac Plus used an external Apple HD-20 hard disk drive; the rest used internal Apple hard disk drives. Hard disk sizes were: Mac SE, 20 megabytes; Portable, II, 40 megabytes; and IIci, 80 megabytes. Both the Plus and IIci had extra memory, which was removed from use by adjusting the size of the RAM cache in the Control Panel.

Figure 2: *The size of the application space for various Macintoshes. The values were measured using SUM II Tools and are approximate. The Mac Portable had the most RAM to spare, the Mac SE the least.*

patch: The new code is loaded into the system heap, and the QuickDraw traps are rerouted to this code rather than to code in the Mac ROMs. These patches to QuickDraw and to the Slot Manager consume 120K bytes of RAM.

The second reason is the critical one, however. Depending on the number of colors you use, each pixel on the screen uses 2 to 4 bytes of RAM. An image using lots of large pixels can gobble up memory rapidly. For example, a small 340- by 386-pixel image (one that would fit comfortably within a Mac SE/30's 9-inch screen) using 32-bit pixels requires about 512K bytes of RAM. The larger the image, the more memory you need. This is why you often hear of graphics professionals using 5 to 8 megabytes of RAM with 32-Bit QuickDraw. Since such images inhale available RAM, you really can't consider using 32-Bit QuickDraw on a 1-megabyte Mac IIci. By eliminating 32-Bit QuickDraw, you also toss out any application that requires it to function.

I eliminated both MultiFinder and 32-Bit QuickDraw because their memory demands are clear-cut. However, from that point on, finding out what will fit—and work—within the confines of a single megabyte isn't as easy.

I'll start with applications. It seems simple enough: You can't use any application that requires more than a megabyte of RAM. You can find out how much memory an application needs by selecting the application on the Desktop with the mouse and requesting a Get Info (either from the Finder's File menu or by typing Command-I) on it. The "suggested memory size" value indicates how much memory the application needs under MultiFinder, but it also gives a rough idea of how much it wants under the Finder. Consider safe any application whose value is less than a megabyte. However, it's the borderline cases, where the application's memory requirements are just over a megabyte, that can give you headaches.

The only way to find out is to try using the application. It sounds simple, but I can give you two examples that show how daunting this task can be. According to the memory-size value, FullWrite Professional 1.0 requires 1124K bytes of memory, and Adobe Illustrator 1.9.3 requires 2000K bytes. Care to guess which application works? If you launch FullWrite Professional, you get a "FullWrite requires at least 1024K to operate" alert, and you get dumped back into the Finder. But Adobe Illustrator runs.

Be careful, however. Even if an application runs, it may not be usable. Adobe Illustrator complains about low memory frequently, and certain Clipboard operations require that you exit Illustrator and then relaunch it to scavenge extra memory to complete the action. Whether or not you care to put up with such nuisances is up to you. Just be aware that some applications that appear too large may be usable.

Another gray area is the realm of INITs and cdevs. The Mac loads INITs at boot time; they extend its capabilities in various ways, typically by patching the Mac OS. You use cdevs to provide control of system functions via the Control Panel desk accessory (DA). I lump cdevs into the same category as INITs because they use an INIT resource to add features to the operating system.

Some of these enhancements are quite useful, and others are a bit frivolous. However, they all use memory in two ways. First, their code is installed permanently into the system heap. Second, as they function, INITs and cdevs might grab additional memory to complete an operation.

Don't plan on having dozens of INITs or cdevs on your 1-megabyte Mac. While some of them only use a few K bytes of RAM, others can snap up 40K bytes or more. As the system heap grows to accommodate them, your application space shrinks. The bottom line is how much you need the INIT and how much memory you can spare for it.

For example, I couldn't do without Steve Christensen's SuperClock! INIT, which puts the time and date in the menu bar and chimes the hour. It only uses 16K bytes of memory. Another can't-live-without cdev is the Adobe Type Manager (ATM). It's a real memory consumer, requiring not only 128K bytes for code, but an additional 64K bytes (minimum) for a font cache. Nevertheless, its ability to provide quality screen fonts at different point sizes is very important in my work, and so I choose to cope with its memory demands.

By examining a certain resource with Apple's resource editor, ResEdit, you can determine quickly if your favorite INIT or cdev is easy on the memory or not. Use ResEdit to open a copy of the INIT or cdev. Scroll through the resource list until you find one called `sysz`. Select and open this resource, and then open the `sysz ID = 0` resource.

According to *Inside Macintosh* volume V, the first long word in this resource indicates the number of bytes the INIT

continued

requires on the system heap. At boot time, the Mac's INIT 31 mechanism uses this value to allocate memory for each INIT resource as it is installed. You can order ResEdit from Apple Programmers and Developers Association for $25.

Packing It In

Now let's put the Mac's memory to some real-world use. Typical jobs that you might need to do on a Mac are word processing, graphics, page layout, and software development. Using System 6.0.4 software, I set up a configuration for each of these jobs that would work in a megabyte. I tried most of these setups on a Mac Plus, SE, II, and Portable. I encountered few problems with each setup, but my tests were by no means exhaustive and they may not match your preferences. However, they should give you a good place from which to start tweaking your system.

One of the first decisions you need to make is what you want to use to manage your DAs and fonts. You can install them in your System file. But INITs such as Suitcase II and MasterJuggler let you have your fonts and DAs in separate files and eliminate some of the Mac OS's annoying limits. These INITs are useful, and I suggest you check them out. Both offer nearly the same features, so what you should consider above all else is the amount of memory they use. Suitcase II 1.2.3 is the clear winner: Its `sysz` resource indicates that it requires only about 10K bytes, while MasterJuggler 1.16 needs 60K bytes.

Word processing makes little demand on memory. Most word processors fit easily within a megabyte and give you few problems unless you're trying to paste gigantic graphics into them. I used MindWrite 2.1, which requires 750K bytes under MultiFinder. This is a worst-case memory usage; most word processors use a lot less. I was able to run MindWrite in combination with ATM 1.01 using a 64K-byte font cache, SuperClock! 3.6, and Suitcase II.

For graphics, most black-and-white paint packages require less than a megabyte. If you're looking for high-resolution output, you might want to try Adobe Illustrator. It works in 1 megabyte, but be aware that you're working at the edge of its limits. Illustrator 1.9.3 worked with SuperClock! and Suitcase II. It displayed fairly complex graphics but got cranky when I tried using the tools extensively. Occasionally it would run out of memory if I tried to save the file with a preview image. If you plan on using Illustrator a lot, you should keep the artwork simple.

For page layout, I used PageMaker 3.0 with Suitcase II, SuperClock!, and ATM to work with an eight-page document that contained several typefaces but no graphics. I could place Encapsulated PostScript graphics or a TIFF image scanned at 75 dots per inch into the document. I had no problem examining the pages at any size or printing the document to a LaserWriter. If your output consists primarily of text, then you should have no difficulty with PageMaker. However, don't try to place a TIFF image scanned at 300 dpi into a document and expect it to work in 1 megabyte, because the higher the resolution of the scan, the more memory it requires.

For software development, I tried both Apple's MPW C 3.0B1 and Symantec's

continued

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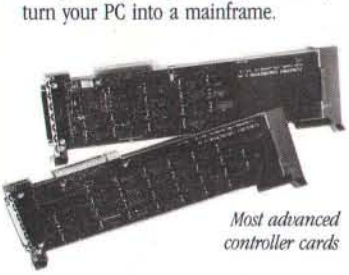

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Think C 4.0. In a megabyte of RAM, neither development system can run its source-level debugger, so you have to resort to the low-level debuggers. You can choose either Apple's Macsbug 6.1 or TMON 2.8.2 from ICOM Simulations. After installing the two debuggers and measuring the size of the application space, I determined that in the memory sweepstakes, TMON is the winner. The amount of memory used by each debugger varied depending on the type of Macintosh, but TMON consistently left me more memory to work with.

Think C operated fine in 1 megabyte with SuperClock! and Suitcase II. I could launch to the test application from the compiler, enter the debugger, and exit from the application back to the compiler without problems. MPW, unfortunately, had problems when compiling multiple files. I'd frequently get an "Unable to swap in shell segment" message when the C compiler completed a file. I fared better when I removed the debugger, but this meant that I first had to compile and link a program and then reboot the Mac to install a debugger before I could test it. I'm not faulting Apple's excellent development software: MPW actually requires 2 megabytes of RAM, but you can make do with 1 megabyte.

Hints for Life at the Edge

Here are a few hints to help you conserve as much of that 1 megabyte of memory as possible.

Use INITs and cdevs that have a sysz *resource.* The INIT 31 mechanism will, by default, allocate 16K bytes of RAM for INIT code that lacks this resource. This default might allocate too much memory for an INIT (wasting precious memory) or not enough. The latter can cause all sorts of problems, notably crashes, which are unpleasant no matter how much memory you have.

Watch your memory! In tight-memory situations, you want some leeway so that an application can recover gracefully if memory runs dry. Try to have a buffer zone of 30K or 40K bytes so that the application can at least present an "out of memory" alert. An excellent shareware DA called Memrometer 3.0 graphically displays the remaining memory as the amount of mercury in a thermometer. Memrometer was developed by Dana Basken and costs $5.

Go easy on the beep sounds. Custom beep sounds are installed in the system heap at boot time. The longer the sound, the more memory it takes. If you insist on something other than that dry department-store Mac beep, use a short tone. A long beep sound of HAL 9000 explaining that he "can't do that" is nice, but it also consumes around 80K bytes of RAM.

The following hints are for Mac II owners.

Avoid the start-up screen. Those colorful images that pop up on the monitor when the Mac II boots can be real showstoppers, but they also wind up in the system heap, and that's RAM that you can't get back. Even a modest-size image can use over 100K bytes of RAM, which effectively implodes your application space.

Use a small screen—preferably one of the 13-inch, 640- by 480-pixel types. The larger the screen, the larger the window an application creates, and larger windows use more memory. Using a 19-inch SuperMac monitor, I could not get Adobe Illustrator to open a file. Once I swapped to a smaller monitor, the application worked adequately.

Use black-and-white mode only. The same reasoning that made me reject 32-Bit QuickDraw applies here. A display that uses 8-bit pixels requires more memory than one using a single bit per pixel. For the Mac IIci, you can reduce the size of the on-board video buffer from 320K bytes to 64K bytes by switching from an 8-bit display mode to a 1-bit black-and-white display mode and rebooting.

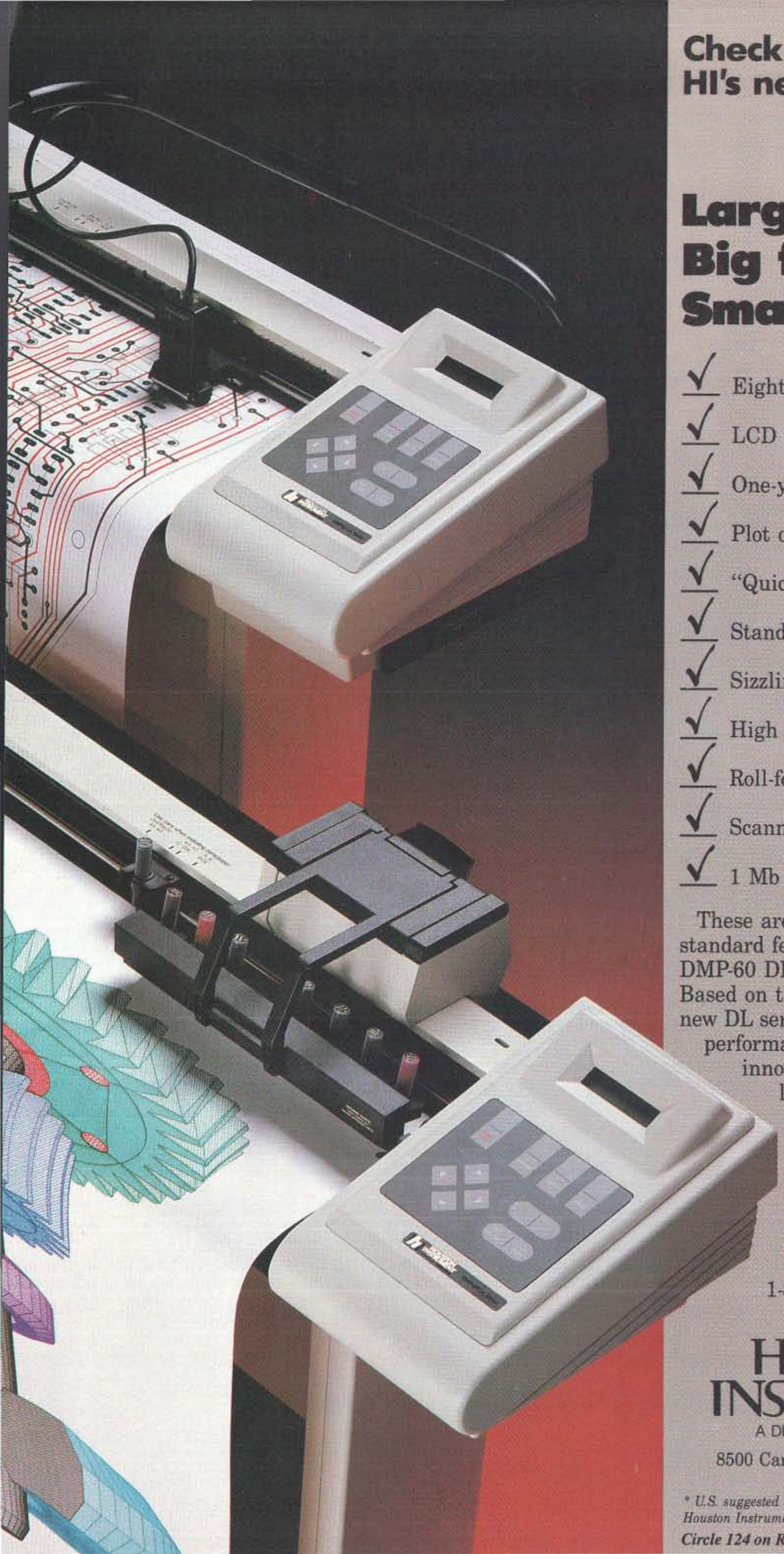
Exploit virtual memory. Connectix has a virtual memory product called Virtual that allows you to use your hard disk as additional memory. You'll need a paged memory management unit chip to be able to use Virtual on a 68020-based Mac II, but you'll need only the software itself to use it on a 68030-based Mac II. The cost of the kit, including the PMMU, is $275.

Let's Get Real

You *can* get work done with a 1-megabyte Mac. You won't be doing sophisticated graphics or a fancy newsletter loaded with high-resolution scans of the staff, but you can do quite well with text-only newsletters and simple artwork.

As long as you realize the Mac's limits and try not to exceed them, you can accomplish a great deal without becoming frustrated by "out of memory" alerts. And with the price of RAM falling, you may soon be able to add extra memory to your Macintosh. Then it will really perform. ■

Tom Thompson is a BYTE senior technical editor at large. He can be reached on BIX as "tom_thompson."



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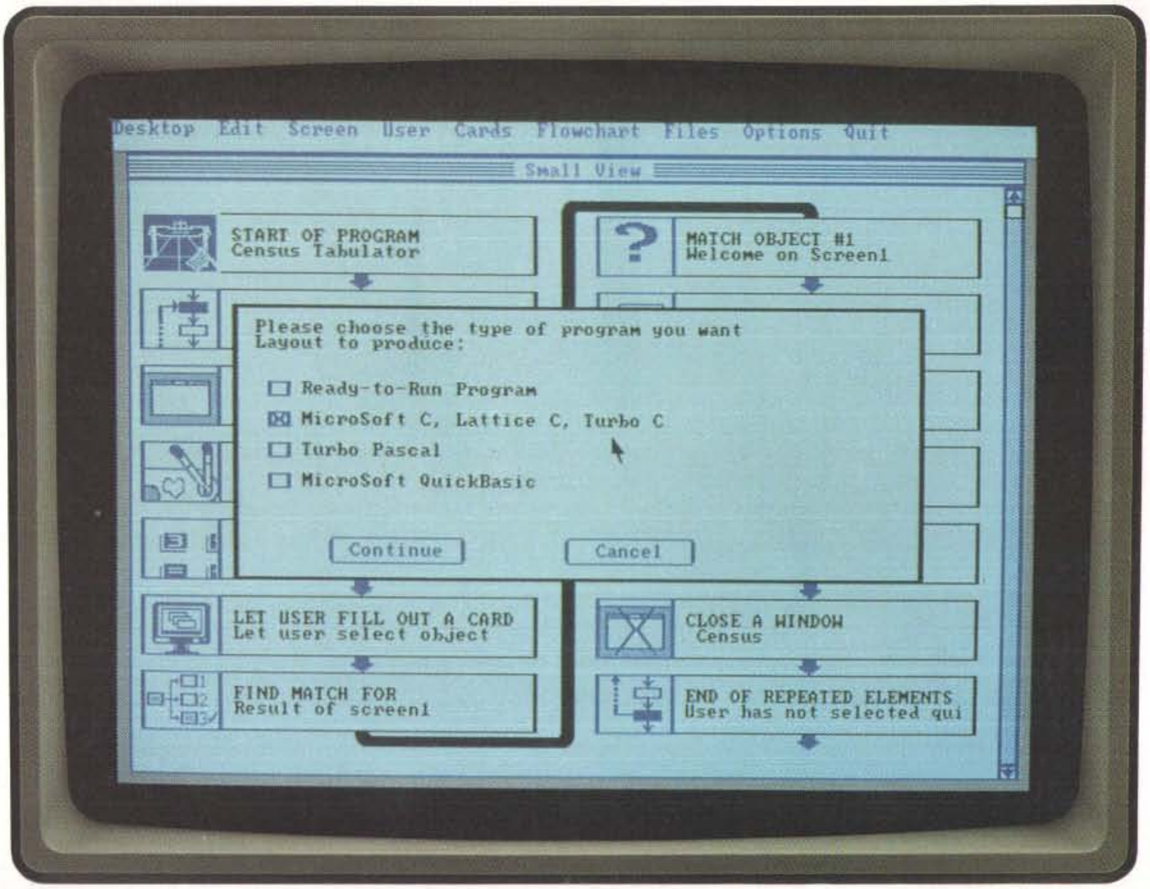

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Easing the RAM-Cram Blues

TSRs can almost lock you out of your own system—but there is help

Mark L. Van Name and Bill Catchings

TSR programs are great. They give you the illusion that you are running more than one program simultaneously in DOS: TSRs "pop up" when you press the right combination of "hot keys." They're always around and always available. However, each one consumes some of DOS's precious memory. If you're not careful, you can end up with lots of useful TSRs and not enough memory to run your applications. This is known as "RAM cram." Luckily, utilities exist to help you ease the RAM-cram blues.

The Origin of RAM Cram

To understand how these utilities work, let's review how DOS views a PC's memory. Because DOS was originally written for the Intel 8088 CPU, it was limited by the 8088's ability to address only 1 megabyte of memory. (The 8086 has the same limitation.) By the time most PC users realized the severity of constraints enforced by the 1-megabyte address-space limit, it was too late: The world was full of PCs. To provide compatibility with those PCs, Intel gave its 80286 and 80386 processors a special operating mode, called *real mode*, where the processor can address only 1 megabyte. Thus, DOS can run on those processors, but only in real mode.

The PC architecture itself further limits the available memory to a mere 640K bytes. It uses the "top" 384K bytes (between 640K bytes and 1 megabyte) for its own purposes: Things like ROM and memory-mapped devices, such as screen memory, live there. Applications have access to the remaining 640K bytes, known as *conventional memory*.

DOS also needs memory—at least 40K bytes—in which to run. And since it loads at the "bottom" of the available memory (starting at address 0), PC applications actually get less than 600K bytes in the middle of the address range, from just above DOS to address 640K (see the figure).

Things get worse. Many devices, including mice and RAM disks, require special drivers, each of which consumes even more memory.

Then there are the TSRs, each of which uses still more of that 640K bytes. A typical set of TSRs might include a thesaurus, a spelling checker, a keyboard enhancer, and a personal productivity tool such as Borland's SideKick. This is where the utilities come in: They let you recover some of the memory your TSRs consume.

How TSRs Work

Most DOS programs interact with memory in a very simple way: DOS loads them into memory just above itself, the programs use all the available memory they want, and then they relinquish that

continued

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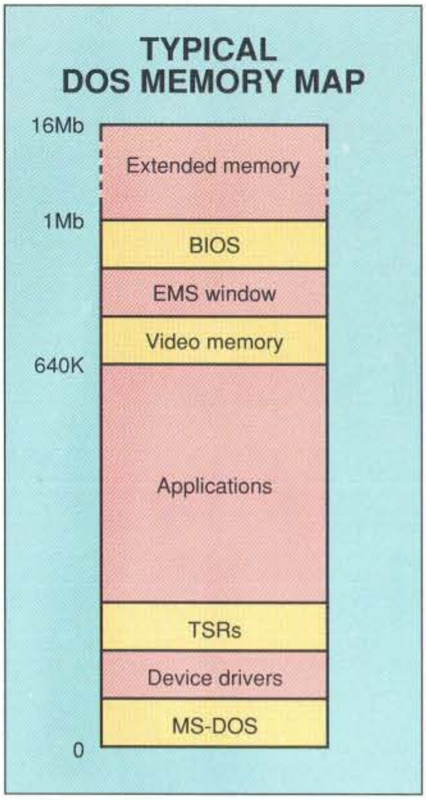


A memory map of a typical DOS environment. Note how elements other than application programs—operating system, device drivers, and TSR programs—nibble away at the oft-quoted 640K bytes of user memory.

memory when they're done.

A TSR is different. It also loads into the lowest available memory, but it doesn't go away when it terminates. Instead, it stays resident in a kind of dormant state, doing nothing but occupying memory. Other DOS programs run as usual, except that the TSR's memory is unavailable to them.

If you load more than one TSR, each one loads on top of the previous ones in a sort of TSR stack. When you hit the appropriate hot keys to bring up a TSR, you're just activating a program that's already in memory.

The TSR wasn't running when you hit those hot keys, however, so how did it "hear" them and start executing? By using a trick that involves interrupt vectors. A PC must handle certain events, such as pressing a key, very quickly, so it generates a special condition—an interrupt—each time such an event occurs. Different events cause different interrupts. Pressing a key, for example, generates interrupt 09 hexadecimal.

When an interrupt occurs, the system has to find the routine that should handle it. The system multiplies the interrupt number by 4 and uses the result to find an address in the interrupt-vector array in memory. Each address in that array points to the routine, typically one in the system's ROM BIOS, that should handle the corresponding interrupt.

A TSR hears a keystroke by putting itself in the middle of this process. In effect, the TSR "steals" the normal keyboard interrupt by replacing the address of its interrupt vector with the address of one of the TSR's routines. That routine checks each key sequence to see if it is the TSR's hot-key sequence. If so, it starts the TSR. If not, it passes the key sequence to the original BIOS key-handling routine—and you never know the difference. The only cost is a tiny bit of system time to execute the TSR's keyboard-interrupt routine.

The situation can actually become much more complicated, because many TSRs can be in memory at the same time, and all of them can steal the keyboard interrupt. When that happens, the TSR loaded last hears each keystroke first. Then it either starts running, or it passes the keystrokes to the interrupt-handling routine whose address it removed from the interrupt-vector array. With more than one TSR, this address points to a routine in the next TSR on the stack. This process repeats until either a TSR finds its hot keys or the keystrokes reach the BIOS for normal processing.

TSRs can steal other interrupts. Another common one is the timer interrupt, which lets a TSR activate frequently regardless of whether you hit a key. TSRs can also become active on interrupts that involve communications activity—a feature especially useful for print spoolers.

A Light in the Dark

If you load a few TSRs into your PC's memory, you can end up with a lot of stolen interrupts and considerably less available memory than you think. Unfortunately, it's not easy to tell exactly which interrupts are stolen or precisely how much memory you have left. Enter Quarterdeck Office Systems' Manifest.

Manifest offers a menu of displays that tell you a great deal about your PC. Most of the information has nothing to do with TSRs, but some of it does. One particularly useful display is Manifest's map of the first megabyte of memory. It shows how much memory DOS is taking, as well as where each device driver and TSR is loaded and how much space each is consuming. You can also see how much memory is available for your applications. Manifest even shows you the name of each TSR, if possible (as long as the TSR has not released its DOS "environment space," the memory area where DOS stored the program's name). The same display shows you the items mapped into the memory above 640K bytes and below the 1-megabyte limit.

Another display presents the interrupt-vector table. It lists every interrupt and tells which program (BIOS, DOS, TSR) currently owns each interrupt. Manifest even highlights the stolen interrupts so you can spot them easily. From these two displays, you can see just what your TSRs are doing to your machine.

Manifest can also tell you a great deal more, everything from details about your machine's configuration (e.g., BIOS maker, disk type, and available DOS variable space) to the results of the program's built-in memory benchmarks. With a retail price of only $60 and a polished user interface that is so simple to use that you never need to crack the manual, Manifest is one program that we think most PC users ought to own.

Blowing the Whistle on TSRs

As nice as Manifest is, however, it only shows you that you're suffering from RAM cram; it does nothing to remedy the situation. Persoft's Referee gives you one way to reduce that problem. Basically, Referee lets you remove TSRs from memory. Most TSRs provide a way to remove them, but you have to use a different command for each one. Referee lets you remove any TSR with a single command. To use Referee, you must load its own TSR, REFWATCH, before you load any other TSRs. REFWATCH keeps track of all the TSRs that you load after it. Then, when you want to remove a TSR, you run the Referee program.

One of the best ways to use Referee is in a batch file. If you had a TSR, such as a spelling checker, that you wanted to load only when a certain application is loaded, typically your word processor, you could run that application with a batch file like this one:

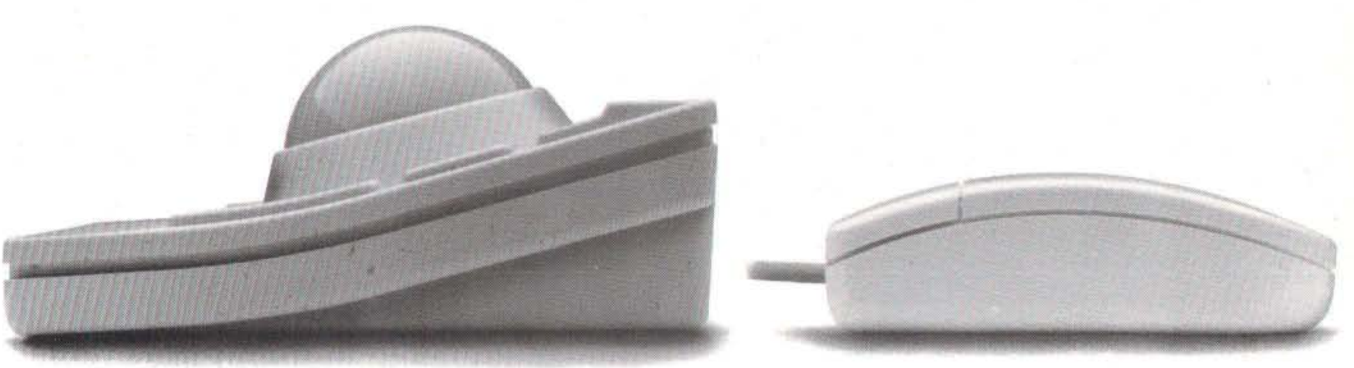
```
spell-checker
word-processor
REFEREE #spell-checker
```

where *`spell`*`-checker` and *`word`*`-processor` are the DOS program names of those applications.

As with the other products in this group, Referee can remove only the most recently loaded TSRs—the top ones on the TSR stack. This limitation makes

continued

How an upside down idea made the mouse obsolete.



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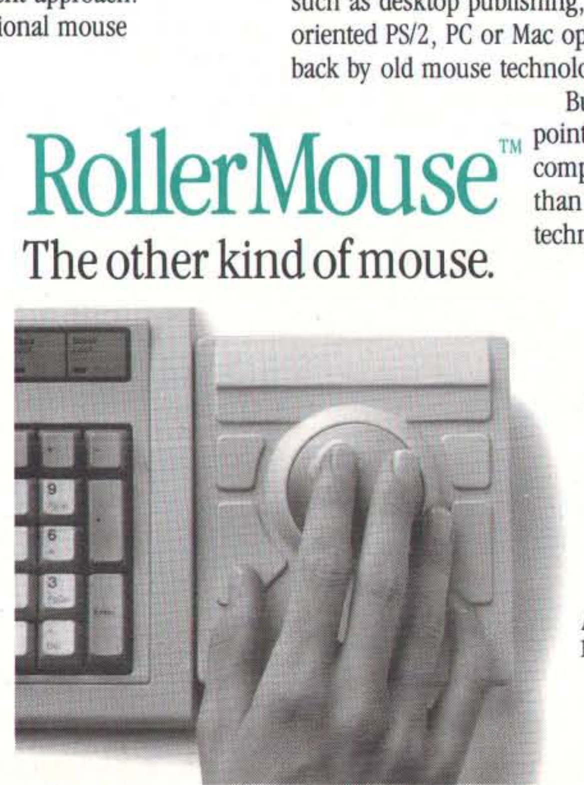

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sense, however, because removing lower TSRs would leave holes in memory that DOS programs couldn't use anyway.

You can also use Referee to deactivate a TSR; it removes all references to the TSR from the interrupt-vector table. Later, when you want to use the TSR, you can reactivate it. These two features were quite useful when TSRs conflicted with one another on a regular basis, but most TSRs today are well behaved and pass stolen interrupts from one to another.

The PopDrop Swap

Another product, BLOC Publishing's PopDrop, works much like Referee. You run PopDrop before you load any TSRs that you might later want to remove. It establishes a "low watermark" in memory. Then you load your other TSRs. The next time you execute PopDrop, it removes all the TSRs above that low watermark. Like Referee, it's a quick and easy way to remove TSRs.

PopDrop actually lets you go a bit further than Referee, because you can establish up to 16 layers of TSRs, each with its own PopDrop low watermark. To define a new layer, you execute POPDROP UP and then load the TSRs you want in that layer. To remove the topmost layer, you execute POPDROP DOWN. You can also roll back several layers at a time, or merely make certain layers inactive.

To help you see any interrupt conflicts, PopDrop can display a list of the stolen interrupt vectors. Similar to Referee, one of the best ways to use PopDrop is in a batch file that lets you bring up a few TSRs with a specific application, as in the following:

```
POPDROP UP
spell-checker
thesaurus
word-processor
POPDROP DOWN
```

PopDrop is actually one half of a package called PopDrop Plus, which also includes a second TSR-management utility, PopLoad. PopLoad is useful only if your PC has extra memory that obeys the LIM/EMS 4.0 standard, which defines how DOS programs can deal with expanded memory, that is, memory outside the 640K-byte user address space. EMS-compliant programs can make EMS memory visible to DOS by mapping sections of it into 16K-byte areas, called "page frames." These page frames can be anywhere in the 1-megabyte DOS address space. There are usually four such frames, so applications can see a 64K-

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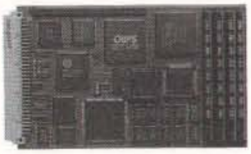

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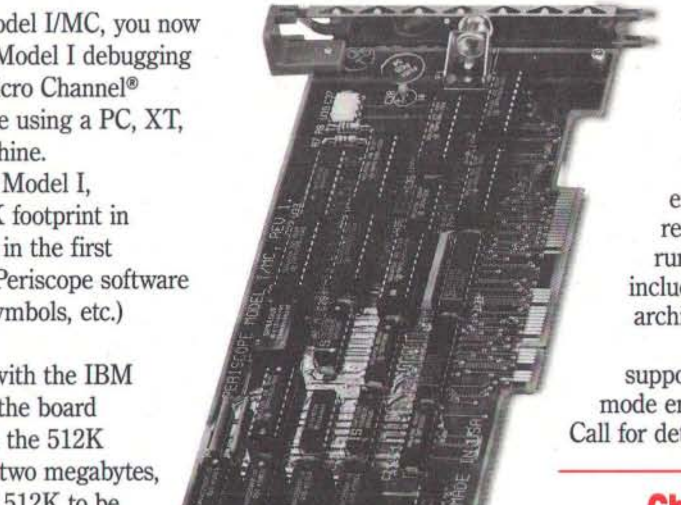

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byte "window" into EMS memory.

PopLoad lets you put TSRs into EMS memory. To use it, you must first put the POPLOAD.SYS driver just after the EMS driver in your CONFIG.SYS file. Then you enter

```
POPLOAD tsr-name
```

to put that TSR into EMS memory. One important limitation: The TSR must be no larger than the largest EMS window your system supports.

You must tell PopLoad all the TSRs that you want to use, as well as the hot keys that you want to use to summon each TSR. PopLoad keeps all those TSRs in EMS memory. When you hit the hot keys for one of them, PopLoad makes it visible through the EMS window so you can use it. One consequence of this approach is that you can only use PopLoad with TSRs that you activate with hot keys. It won't work with TSRs, such as print spoolers, that activate themselves by stealing other interrupts.

Making Headroom

Like PopLoad, Helix Software's Headroom can also use EMS memory to remove TSRs from DOS memory space—but it can do much more as well. Rather than having TSRs live in expanded memory, Headroom stores them in a "swap area" until you need one of them. That swap area can be LIM/EMS 3.2 or 4.0 memory, extended memory, or even a hard disk file. (Extended memory is memory above the 1-megabyte line. It is available only on 80286, 80386, and i486 processors, and then only when those processors are not running in real mode, to which DOS is bound.)

Using Headroom is a multistep process. First, you run Headroom before any TSRs you want to swap. Then you load those TSRs and run another Headroom program, Swapout, which creates an image of the target TSRs in the swap area. Then you must bring up Headroom and tell it which hot keys you want to use to activate them. Headroom saves those key assignments, as well as other information it needs, in a configuration file on your disk. Finally, you add Headroom to your AUTOEXEC.BAT file and reboot your PC. When Headroom runs, it uses the configuration file to load those TSRs automatically.

When you hit the hot keys of one of the swappable TSRs, Headroom rolls the appropriate TSR into conventional memory. When you exit the TSR, Headroom moves it back to the swap area. The only difference between swapping a TSR to expanded memory, extended memory, or a hard disk is speed.

Unlike PopLoad, Headroom offers a long list of TSR-activation events, including timer ticks, a set amount of CPU idle time, serial-port communications activity, and DOS function calls. You can also use a special command, XRUN, to execute TSRs smaller than 64K bytes directly from an EMS window—much like PopLoad runs them.

Headroom offers many other features as well. If you have EMS memory, you can swap out any device driver that fits in the 64K-byte EMS window. This works with the ANSI.SYS, MOUSE.SYS, and VDISK.SYS drivers. But, you should use this feature with care because it might not gain you any memory. ANSI.SYS and VDISK.SYS, for example, are smaller than the driver that Headroom uses for swapping.

Headroom even lets you swap entire applications, so that inactive applications wait, as TSRs do, in the swap area. You can have up to 32 application *partitions*, or memory areas, each of which can be as large as the amount of conventional memory left after DOS and Headroom load. Headroom stores the inactive partitions in the swap area. When you hit a partition's hot keys, Headroom moves the current partition into the swap area and the one you summoned into conventional memory.

Headroom's biggest drawback is its hypersensitivity to system changes. You must redefine your Headroom TSR configuration file every time you make any change in system-memory usage, even if you just change the number of buffers in your CONFIG.SYS file. The documentation is rough and opinionated, but Headroom offers more raw TSR-management features than any other product in the group.

Low-Cost Multitasking

While application swapping is almost a secondary feature of Headroom, it is the central focus of SoftLogic Solutions' Software Carousel. This product works much like the application-swapping feature of Headroom. You can hot-key up to

continued

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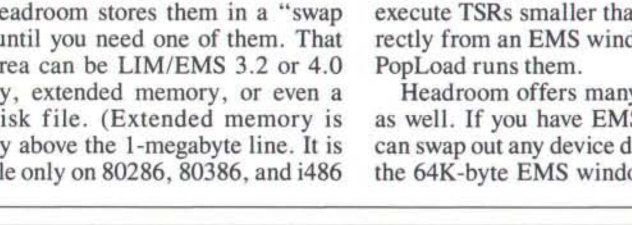
Parallel Port Interface (PPI)



Key Tag

The parallel port interface (PPI) connects between the printer port on a PC and the printer cable. The PPI holds two Key Tags, one on each side. Each Key Tag contains a secure custom chip which is pre-programmed by Glenco to only work with the assigned software package. A second Key Tag can be employed to protect another package, or may be used to turn other software packages "on", remotely or on-site.

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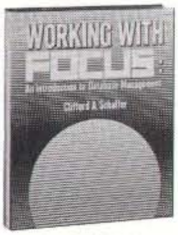

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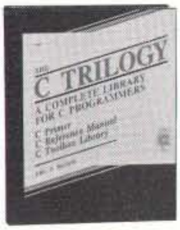

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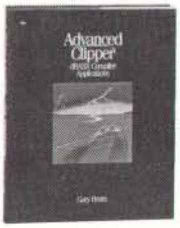

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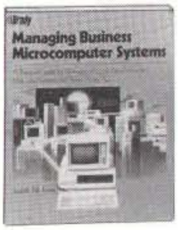

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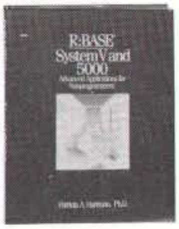

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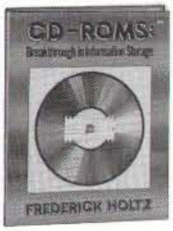

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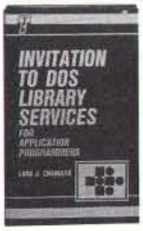

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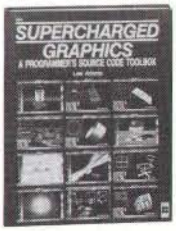

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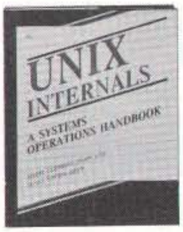

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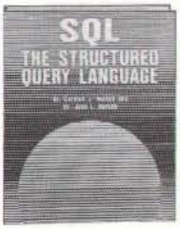

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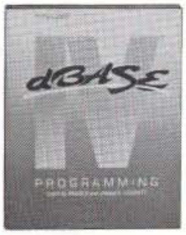

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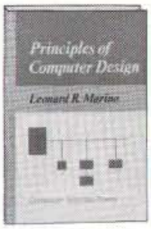

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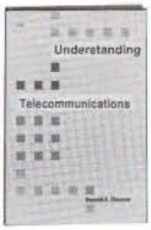

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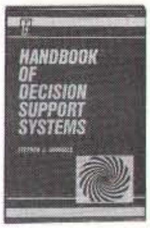

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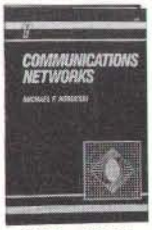

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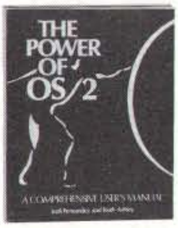

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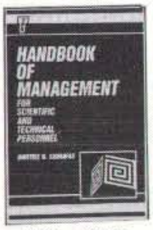
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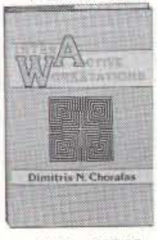

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12 applications. Each application lives in a partition that can be as large as the amount of conventional memory left after DOS and Software Carousel load.

Also, like Headroom, this program keeps all but the active partition in a swap area in expanded or extended memory, or on disk. But because you can put TSRs in each partition, Software Carousel can manage TSRs as well as applications. Only the TSRs in the active partition consume conventional memory.

Not surprisingly, you can run only the TSRs in the active partition. Also, each TSR can work only with the application and other TSRs in its partition. If you want to use a spelling checker with a word processor, both must be in the same partition.

When it comes to TSRs, Software Carousel is most useful in two situations. The first is when you have a TSR, like SideKick, that you can put in its own partition. The second is when you have TSRs that you want to use only with specific applications. You can, for example, have one partition with a spelling checker, thesaurus, and word processor, while another partition contains a mouse driver and paint program. No partition has to pay the memory cost of a TSR that it doesn't need. Software Carousel also lets you have several applications available at once when you don't have the money or system power to run a more complicated application manager, such as Microsoft Windows or Quarterdeck's DESQview.

Curing Claustrophobia

All these products can help you manage TSRs, so, to some degree, you can't go wrong with any of them. Be sure, however, that your PC has the resources that your choice requires. For example, while Manifest, Referee, and PopDrop will run on any system, PopLoad requires LIM/EMS 4.0 memory. And Headroom and Software Carousel need expanded or extended memory, or a hard disk.

TSRs are extremely useful tools, but when allowed to run rampant in memory, they can make your applications claustrophobic. You can end up almost locked out of your own system. However, one of these utilities can help you get your space back. You don't have to sing the RAM-cram blues anymore. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and free-lance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.

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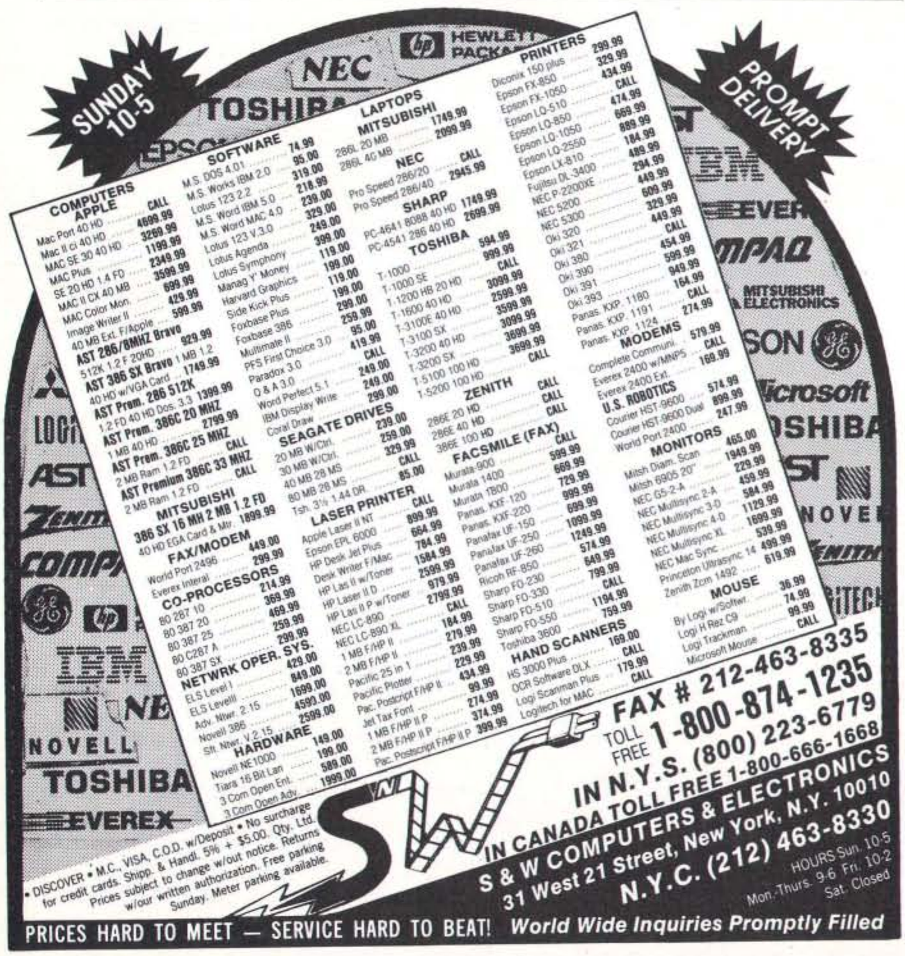

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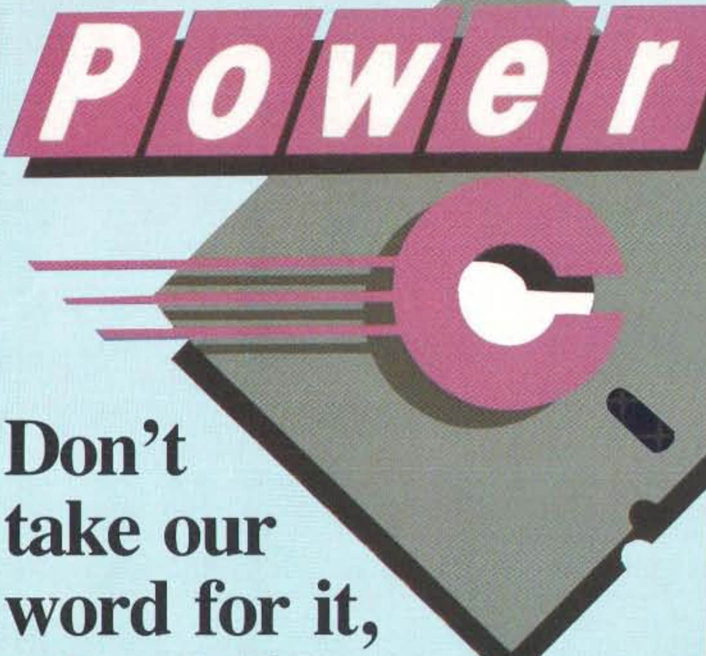

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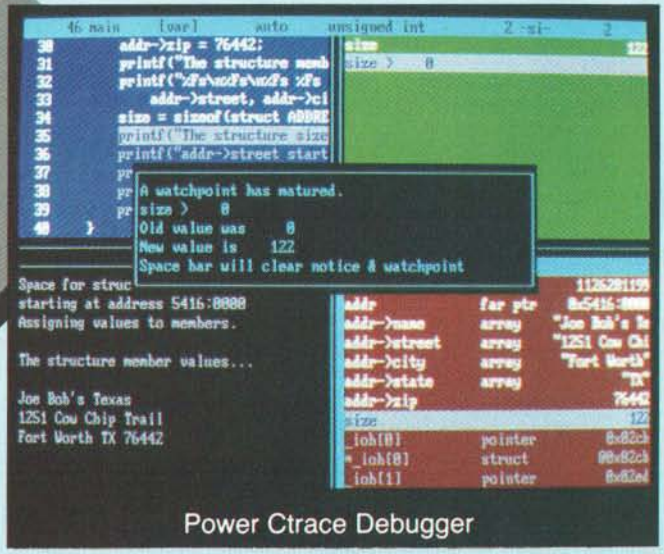

```
46 main      [var]        auto        unsigned int        2 -si-        2
       addr->zip = 76442;                     size                           122
       printf("The structure memb             size >     0
       printf("%Fs\n%Fs\n%Fs %Fs
          addr->street, addr->ci
       size = sizeof(struct ADDRE
       printf("The structure size
       printf("addr->street start
       pr
       pr A watchpoint has matured.
       pr size >     0
   }      Old value was      0
          New value is     122
          Space bar will clear notice & watchpoint
Space for struc                                                        1126281195
starting at address 5416:0000      addr               far ptr   0x5416:0000
Assigning values to members.       addr->name         array     "Joe Bob's Te
                                   addr->street       array     "1251 Cow Chi
The structure member values...     addr->city         array     "Fort Worth"
                                   addr->state        array             "TX"
Joe Bob's Texas                    addr->zip                           76442
1251 Cow Chip Trail                size                                  122
Fort Worth TX 76442                _iob[0]            pointer         0x82ch
                                   *_iob[0]           struct         00x82ch
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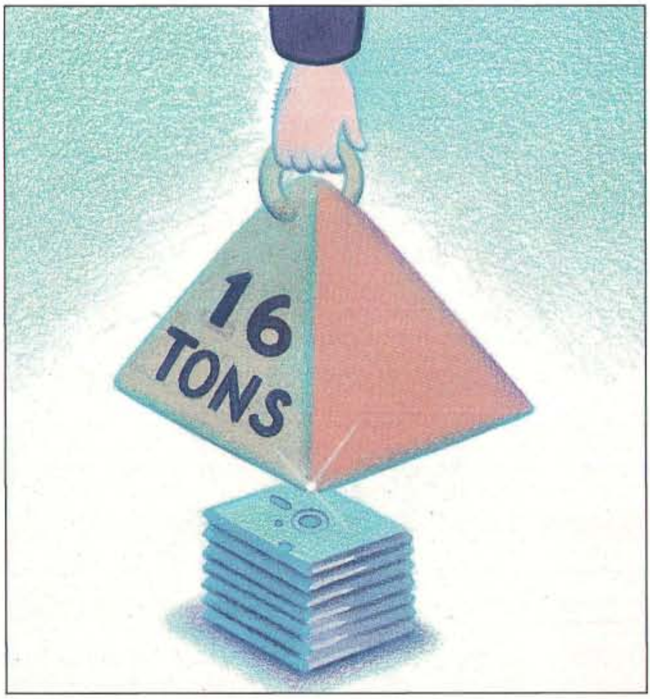
Saving Space

Data compression can add years to the life of your hard disk for a lot less than the price of a new drive

Steven J. Vaughan-Nichols



It's not that your computer is any slower or smaller than it ever was before, it's just that you seem to keep running out of disk space. Hardware keeps getting bigger and faster, and software keeps getting fatter and fatter.

There was a time not so long ago when dBASE and WordStar would fit on a single floppy disk. Now, no matter what size hard disk you have, it's probably nearly full.

There must be a better way to keep all this capability accessible without having to add more storage space every few months or save it all on floppy disks. Well, as a matter of fact, there is. Data compression won't make your hard disk any faster, but it will allow you to keep more of those overweight applications on the hard disk where they belong instead of gathering dust on floppy disks in your desk drawer.

Making More Room

Most of us already have a word processor, a spreadsheet, and a database program. These days, those alone may be enough to overflow a hard disk. By itself, dBASE IV takes up almost 3 megabytes of storage space. However, using a program called PKzip, you can squeeze it down to about 1.6 megabytes.

If you don't want to be bothered with shrinking and expanding files manually, you can set up batch files to do it automatically. I wrote a batch file for dBASE IV named `pack4.bat` containing

```
pkzip -m -xpack4.bat -xgobase.bat
dbase.zip *.*
```

This moves all the files in my current directory, except for the batch files, into the archived file `dbase.zip`. Then, when I want to use dBASE, I run the `gobase.bat` batch file,

```
pkunzip dbase.zip
del dbase.zip
dbase
pack4
```

which lets me run the program. When I'm finished, it packs dBASE up again and releases more than a megabyte of disk space for work.

The `pack4.bat` file isn't fast, taking almost 5 minutes to run, but it certainly beats having no room on your hard disk. Once compressed, though, the file takes only a minute to deploy the program for action. You could set up similar batch files for almost all your applications.

Realistically, you could, with a watchful eye on total space requirements, maintain a 20-megabyte hard disk containing 25 megabytes of files. Data-compression programs squeeze files down more effectively than this indicates. However, they require available space equal to the size of the uncompressed

continued

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Squeeze, Squash, and Crush

Programs that archive files can seldom make heads or tails of their competitors' file formats. The compression methods are disguised under colorful names like squeeze, squash, freeze, pack, and crush, but they are all based on four data-compression algorithms: Shannon-Fano, Huffman, Lempel-Ziv, and its close relative, Lempel-Ziv-Welch (LZW).

Having the same theoretical underpinnings, however, doesn't mean that the file formats they produce are any more compatible than most word processors' text files. If anything, the problem is even worse than trying to read WordPerfect files with XyWrite.

Data-compression algorithms are deceptively simple. Almost anyone can translate one into a program. However, the results depend on the programmer, whose skill determines whether the finished product will be a triumph or a disaster.

Currently, the most popular data-compression algorithm is LZW, which has been used in both ARC and PKzip. It has the dual advantages of being both fast and effective and thus is the one I will concentrate on here.

To follow the LZW algorithm, you prepare a matrix that can hold several thousand items. Positions 0 through 255 are initialized to the standard ASCII character set. The uninitialized positions have strings assigned to them as new data is entered. Each unique string is assigned its own position.

These positions serve as codes that are used to encrypt a file into its compressed form. If a particular string already has a position, then the output is the position that corresponds to the string, and the data-compression process has begun.

When the matrix is full, the oldest or least-used position is reinitialized to the new string. There's no attempt to make the best possible choices for effective compression, but it gets the job done remarkably well.

The decompression algorithm incrementally rebuilds the string table from the encoded data. It re-creates the translation table, positions, and data elements from the compressed version of the original string data.

This is one of LZW's strongest features. The other data-compression algorithms, notably Huffman coding, require that a translation table be included in the compressed file. Since LZW files don't have to carry this extra baggage around, they have an inherent space advantage over the other data-compression schemes.

There are two problems with implementing the LZW algorithm. The first is that you can't predict the optimal matrix size in advance. This variable depends entirely on the type of data being handled. Attempts to deal with this problem quickly lead away from the elegant simplicity of LZW.

The second difficulty is that every time you add a new string, you must search the table. In other words, you must install a hashing system to provide quick searches during the compression process.

This is easier said than done. A poor implementation can be extremely slow. Extracting data, fortunately, is much faster.

Because of these and other problems with the remaining three algorithms, data-compression programs are difficult to perfect. The usefulness of the end product and the fascination of such simple solutions (which are so hard to put into effective practice) ensure that more data-compression programs will be forthcoming.

---

files that they're working on.

Theoretically, you could keep even more files on disk, but juggling space requirements during decompression would be too much trouble. The only files that you should never place in an archive are your essential DOS files and anything that's important enough to put in your `path` statement.

You can also save a significant amount of space by compressing just your data or text files. Worksheets, manuscripts, and databases frequently contain large amounts of empty space and redundant characters, which makes them ideal for data compression. You can easily use a data-compression program to bundle together, for example, your correspondence files.

Evolution by Frustration

Two forces have pushed the evolution of data-compression programs. The first was the limited size of microcomputer hard disks: They have never been big enough.

There must be a rule somewhere that dictates that files will increase to fill a disk's capacity within three months of that disk's installation. It wasn't long ago that 5 megabytes was considered a decent-size hard disk, but now 30- or 40-megabyte disks seem limited. Even 80 megabytes seems none too big. Some days, when I look at WordStar 2000 or Oracle with their multiple floppy disks, it doesn't seem like much progress has been made.

The second impetus to data-compression programs came when people started using 300-bps modems to send files back and forth to each other. The only thing that didn't take long at 300 bps was becoming frustrated at how long it took to do everything.

The solution to these two problems was to squeeze files into smaller-size packets so that less time was spent staring at flickering modem lights as the files crawled back and forth. Although file transfer rates have increased significantly since that time, the desire remains to increase the speed on these activities even more. (See the text box "Squeeze, Squash, and Crush" above.)

The first archiving programs were invented almost a decade ago when CP/M was microcomputing's dominant operating system. Dick Greenlaw created the first of many programs in this software family when he released SQ and USQ (short for squeeze and unsqueeze) into the public domain. Not long after that, programs like LU (library utility) and NULU (new library utility) enabled users to collect sets of related files into a library.

Today, there are five major data-compression programs for DOS users to choose from: ARC 6.02, LHarc 1.13, PAK 2.1, PKzip 1.02, and Zoo 2.01. In some ways, all these programs are very much alike. You issue commands to them by setting flags after their names at the DOS prompt.

These are commands that only a DOS guru could love. However, once you learn the command syntax for one of these programs, you are close to knowing it for all of them, because they're all

continued

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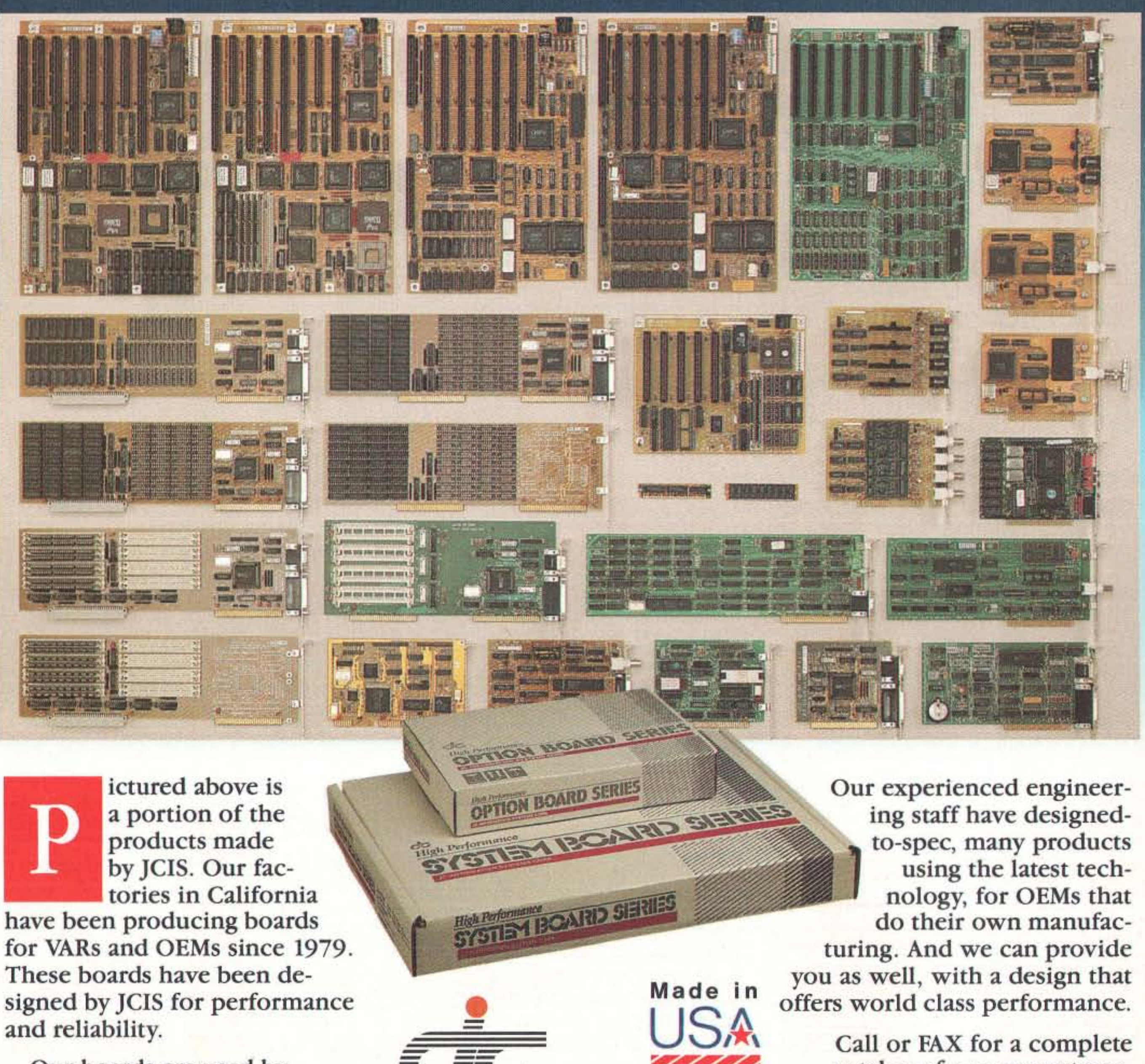

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Legal Seagull

The cottage industry of DOS data-compression software weathered the storm of its two biggest players, System Enhancement Associates (SEA) and PKware, battling in court in 1988. The stakes may not have been as high as in Apple versus Microsoft, but the feelings ran as strong.

SEA sued PKware for its use of SEA's trademark "ARC" to describe PKware's data-compression program, for piracy of SEA's unique code, and for stealing the look and feel of SEA's program.

SEA was successful. The case was settled out of court in August 1988. PKware's program, PKarc, was taken off the market, its source code has been turned over to SEA, and PKware has paid an undisclosed amount in compensation to SEA.

What SEA won in the courtroom, though, was lost in public relations. The on-line community saw the company as having violated the spirit of shareware and was almost universally hostile to the suit. It showed its disapproval by attempts to organize boycotts and letter-writing campaigns.

No one could have guessed that systems operators, shareware programmers, and on-line users would feel so strongly about what most observers thought was a minor dispute.

Matters only got worse for SEA when it filed another lawsuit claiming that PKware had violated the agreement from the first suit regarding the use of the term "ARC." This second suit merely poured gasoline on the already hot flames of public opinion.

SEA tried to reclaim support with a policy statement spelling out its position and stating that it would continue to foster shareware. The statement does not appear to have worked.

SEA lost the second suit in October 1988 and found itself in a catch-22 situation. SEA had to defend its trademark, which it had taken great pains to establish, but in doing so, it was alienating its potential users. There were predictions that within a year the ARC standard for file libraries would disappear from on-line services and BBSes.

The prophets were, for the most part, correct. SEA won the primary legal battle, but lost the business war. Undampened by the turn of events in the courtroom, Phil Katz, president of PKware, returned to the keyboard and came up with his best work yet.

The combination of public sentiment and PKzip's marked superiority over the rest of the field quickly swept it to undisputed leadership in on-line data compression.

SEA continues to hold a strong presence in commercial software products where ARC is used to store programs until they are installed on a hard disk. However, with its roots in BBSes and on-line services, ARC is vanishing from its birthplace.

descended from NULU's commands.

These programs not only share commands, they also share bugs. Data compression is an extremely disk-intensive operation. All the programs require at least as much free space on the disk as the files being worked on occupy. Unfortunately, none of them bothers to determine whether sufficient space exists on the disk to accomplish the job before starting.

Not only does this imprecise approach waste your time, but Zoo and ARC also leave temporary workfiles around cluttering up your disk. Adding insult to injury, the programs that leave these half-done files behind don't even tell you that they've done so.

Despite these problems, however, every one of these programs excels in one area: They don't lose data very often. PAK and Zoo let you overwrite files of the same name when they extract files from archives, but you have to go out of your way to make a mistake like that. The others always ask you if you really want them to overwrite a file before they'll do it.

The data-compression routines in all these programs are robust. I've never lost a single byte, and I've been using them for years.

ARC 6.02

System Enhancement Associates (SEA) was one of the first companies in the data-compression field. For several years, its product, ARC, was synonymous with data compression.

But things have changed. ARC is a run-of-the-mill performer that has been

continued

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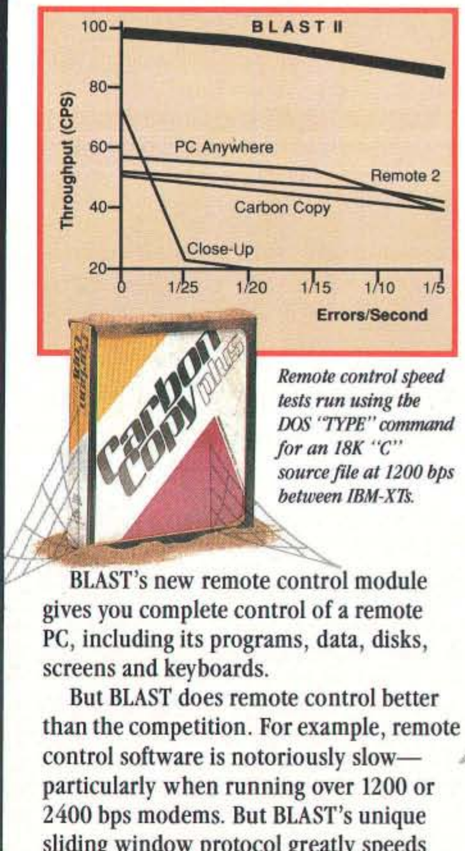

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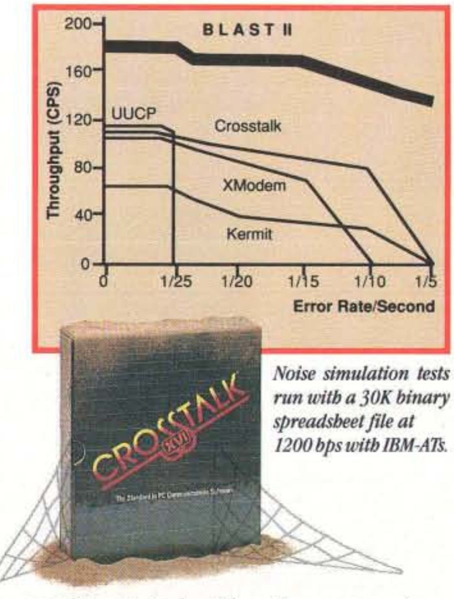

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WANG	VS
PRIME	PRIMOS
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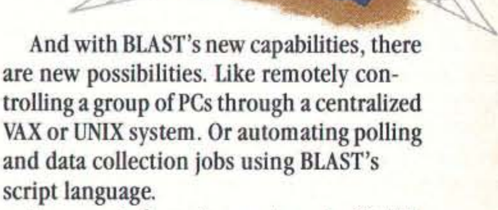

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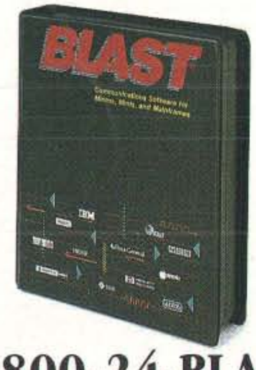

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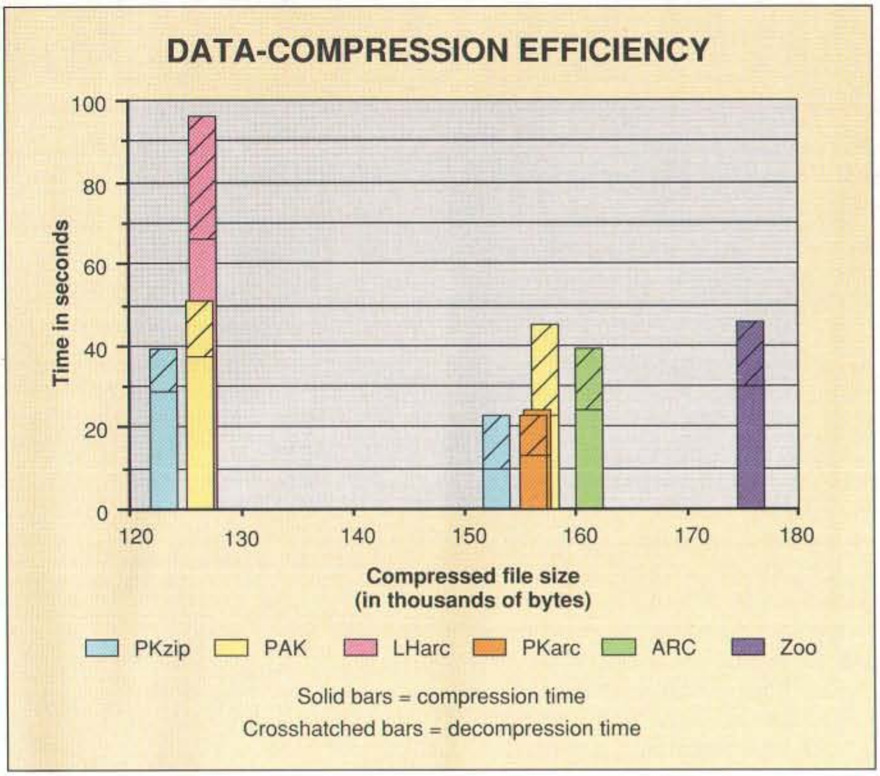

Starting with a combined file size of over 300,000 bytes, the different archiving programs achieved quite different results. Notice that to achieve a compressed file size of less than 130,000 bytes requires, on average, considerably more compression/decompression time.

left in PKzip's dust. Ever since PKware entered the field, SEA has been playing catch-up.

ARC just doesn't work as well as PKzip. It also has a bad habit of not cleaning up after itself. When it doesn't have enough room to finish compressing files, it plows ahead anyway until lack of space forces an abort and leaves you with a half-baked archive file.

ARC was a good product in its day, but its day is over unless changes are made. There are other programs now that run faster, squeeze tighter, and have more options.

If, however, you download programs from on-line services like BIX and CompuServe or from BBSes, ARC is worth having, because there are still a lot of ARCed files out there. Otherwise, I'd recommend you spend your time and money elsewhere.

LHarc 1.13

The newest entry in the file-shrinking derby is LHarc. This program is the result of several Japanese computer hobbyists' efforts to perfect the process of data compression (it is copyrighted by Haruyasu Yoshizaki).

This program is effective at shrinking files, but it takes its own sweet time doing so. It is by far the slowest of the five programs.

LHarc has problems that keep it from becoming the dominant player in the data-compression game. For one thing, it is somewhat more difficult to use than the other programs. The LHarc commands don't work quite the way you expect them to. In fact, some of them don't work at all. For example, I never was able to get the self-extracting archive feature to run.

This program follows the usual command syntax. That's a good thing, because the program's manual is just plain awful. But you can at least get the basic instructions by running the program without any parameters or arguments on the command line.

There is one great virtue to LHarc, however: It makes very small files (the prime purpose of data compression). Despite this, the program is so slow that I can't recommend using it on XT-class hard disk drives. The increased speed of an AT-class-or-above hard disk drive should help a little.

It's encouraging to see a good public domain program, but, as with many other free programs, you get more of a work-in-progress than a finished (never mind polished) product. Future editions of the program may solve its problems, but, for now, I'd pass LHarc by.

PAK 2.1

NoGate Consulting's program is called PAK. Rather than trying to beat PKware at the speed game, its main selling point was that it makes smaller files than its competitors. Consequently, it is neither the most efficient nor the fastest.

One of the advantages of PAK is its simple graphical display that shows how much progress the program has made in shrinking or expanding files. This is very reassuring. It certainly beats watching the hard disk drive's light flicker on and off and wondering if the program is working or if your hard disk is in serious trouble.

PAK is the one program that tries to be compatible with the others. It can convert files made by older versions of ARC and PKarc to its own system. It can also create archives that ARC and PKarc can read and extract.

PAK 2.1 is a good program that, until this recent release, had been left behind in the rapidly changing world of data compression. It was never one of the more popular programs, being far outdistanced by ARC and PKzip. However, the current version may put it back into the race.

PKzip 1.02

PKzip is the undisputed champion of data compression. The program simply does everything better than all the others in this group. PKzip makes the smallest files without taking a great deal of time, and that's the name of the game in this business.

If you spend a lot of time file-hunting on BBSes and on-line services, you know about PKzip. It's the de facto standard in the IBM PC-compatible communications world.

Informal standards grow in computing with a life of their own. However, there are times when a good program or idea is the one that takes hold, rather than simply the first program that works. PKzip is one program that you definitely won't regret being "forced" to use. (Another reason for PKzip's popularity is detailed in the text box "Legal Seagull" on page 240.)

PKzip is well ahead of the pack. It's the only one of these programs that can be used safely on a LAN. The program uses the SHARE command, available in

DOS versions beginning with 3.0, to ensure that the files involved in a zip operation won't be damaged by another user trying to access them while PKzip is working.

This isn't to say that PKzip is perfect; it's not. You have to use a separate program, PKunzip, to extract files from a zipped archive.

It's unclear why the archive-making and archive-extracting processes are divided into two separate programs. There is nothing to be gained by making the program slightly harder to use. PKzip does, however, allow you to make compressed files that extract themselves at the cost of an additional few K bytes of file size.

Another problem is that its most effective setting is also its slowest. This can be irritating, but sometimes space benefits outweigh time penalties.

PKzip's advantages make it the best choice of the many data-compression programs now available. For once, the most popular program and the best product are the same.

DATA-COMPRESSION RESULTS

These results show the utilities tested in order of their compressed file sizes (which is, after all, the purpose of data compression). Some of the programs are listed more than once due to the use of different algorithms. (Method = the type of compression algorithms used by the program; Size = the number of bytes in the compressed file; Ratio = the size of the compressed file versus the size of the uncompressed file; and Time = the average time, in seconds, required to perform the operation.)

Software	Method	Size	Ratio (percent)	Compress time	Extract time
PKzip/PKunzip 1.02	ZIP	123,572	40	29	10
PAK 2.1	PAK	126,450	42	37	14
LHarc 1.13	LHarc	126,844	42	66	30
PKzip/PKunzip 1.02	ZIP[1]	153,257	50	10	13
PKarc/PKxarc 3.5	PKarc	156,928	52	13	10
PKarc/PKxarc 3.5	ARC[2]	156,957	52	13	11
PAK 2.1	ARC	157,421	52	23	22
ARC 6.02	ARC	161,319	54	24	15
ARCE 3.1c[3]	N/A	N/A	N/A	N/A	14
Zoo 2.01	Zoo	175,852	58	30[4]	16

[1] PKzip has two options for file compression. The first is slower but does a better job. The second is much faster but does only a slightly better than average job of compressing data.

[2] PKarc allows users to make ARC-compatible files.

[3] ARCE is an SEA utility that decompresses archives faster than ARC.

[4] Zoo 2.01 doesn't handle wild cards the same way the other programs do. Specifically, when given the DOS wild cards *.* or *, Zoo did not compress the file "manual." The test wrote a batch file that made Zoo add the file to the archive immediately after the archive had been created with the other files. This process made the program's time slower than the others, since it had to be invoked twice. On the other hand, the time is still faster than it would have been in real-world operations on the same files.

Zoo 2.01

Zoo isn't the best data-compression program, but it does have certain advantages that the others cannot claim. It lets you automatically store and selectively extract multiple generations of the same file. This may not sound like much, but it can be an invaluable aid for keeping earlier, but still valuable, versions of code or manuscripts.

Unlike the other data-compression programs, Zoo spans several operating systems. There are versions of Zoo for Unix, VAX/VMS, and AmigaDOS. File transfers between these very different operating systems are much easier with Zoo's help.

Zoo is the most difficult of these programs to operate. There is an on-line help screen, but it's not terribly helpful. Its writers clearly knew more about bytes than help.

Zoo comes equipped with a utility named Fiz to restore data from damaged Zoo archives. Although it's not quite as hard as restoring a damaged file allocation table with only DEBUG, you're almost better off starting over with a backup copy. I've never had a Zoo file go bad, though, so I think it's unlikely that you'll need to use Fiz.

If you need to keep multiple copies of works in progress, or if you are frequently porting files between the Zoo-supported operating systems, Zoo is well worth picking up. However, it simply doesn't work well enough to be considered for hard disk tuning. The program, copyrighted by Rahul Dhesi, is available at no charge.

Testing, Testing

To determine which program was best, I ran a series of tests on each one. I used an AT-compatible computer running at 12.5 MHz with a 40-megabyte hard disk drive with an average raw access time of 28 milliseconds and a 32K-byte hardware disk cache adding to its speed, operating under MS-DOS 3.3. I ran all the tests on a defragmented hard disk. I cleared off the files produced by one test before running the next one.

I ran the tests on a set of 10 files. Nine of them consisted of the executable, overlay, and text files for Procomm 2.42, a shareware communications program. The tenth file was a 96,921-byte ASCII text file.

The test data's final tally came to 184,456 bytes of binary files and 118,635 bytes of ASCII files for a total of 303,091 bytes spread across 10 files. This was a large-enough sample of real-world files to allow each program a chance to show its stuff. Although most of these programs let you use a different disk or directory for workspace while the compression process is running, I didn't use this option to test them.

To provide a comparison with the last generation of software, I have included results for PKarc 3.5. See the table and the figure.

Too Useful Not to Have

A data-compression program belongs on every small hard disk, and on a lot of big ones as well. These programs may have crude user interfaces, but they're too useful not to have.

My recommendations? PKzip should be the program of choice for most people. However, Zoo's ability to bridge a variety of different operating systems makes it a must, despite its warts, if you need to move data from one system to another.

Both of these programs show their humble origins in shareware with their packaging, but they can add years of life to your hard disk for a lot less than the price of a new drive. ■

Steven J. Vaughan-Nichols is a programmer/analyst for Bendix Field Engineering Corp. (Seabrook, MD) supporting NASA communications. He can be reached on BIX as "sjvn."

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More Bang for Your Buck

These integrated software packages cram a lot of features into a small space—for a small price

Mark L. Van Name and Bill Catchings

Three applications—word processing, spreadsheets, and database systems—have long dominated microcomputer software. Just about every personal computer user works with at least one of them, and many use all three. Not everyone, however, requires expensive, full-featured packages. Some microcomputers, in fact, lack the resources to properly handle many large applications—laptops and older XT and AT systems being prime examples. If you own such a system, or if you want to keep costs and memory requirements to a minimum, you should consider integrated software.

Integration's Advantage

Integrated software packages cram spreadsheet, word processing, and database applications into a single product. The individual applications typically don't have the power of dedicated programs, but the combination can meet all the day-to-day needs of many users.

These products come in many sizes, from huge, multimanual brutes to smaller and simpler programs that you can learn quickly and easily. If you need to outfit a laptop, portable, or other 1-megabyte (or less) machine, these smaller products offer many advantages beyond their ease of use.

For one thing, they're inexpensive. We'll examine four products in this article: Alpha Software's AlphaWorks, Microsoft's Microsoft Works, Software Publishing's PFS:First Choice, and Spinnaker Software's BetterWorking Eight-in-One. All retail for under $200.

For another thing, these products demand little from a microcomputer: They run easily in 640K bytes of main memory (using overlays) and take up at most a few megabytes of disk space. Microsoft Works even has an installation option (ideal for laptop owners) that lets you prepare a working copy of the program that fits on a single 3½-inch 720K-byte floppy disk. (That disk, however, has only 45K bytes free, so plan on using a second data disk.)

Although small, these programs do require some room on a hard disk. With all the available tutorials, features, sample data, and help files installed, they consume from a low of about 1.3 megabytes of disk space (PFS:First Choice) to a high of about 2.5 megabytes (Microsoft Works). Those numbers don't include space for data, so it's best if you have a few megabytes of free hard disk space.

Those few megabytes of disk space contain a wealth of features, however. All these products offer a strong set of basic word processing, spreadsheet, and database functions. All support a wide range of printers. They also add some basic communications functions to the

continued

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big three applications. Most also include a few personal-information-management extras, such as a calculator, appointment calendar, or simple DOS file manager. These products are ideal for the many situations where using full-featured software is an exercise in overkill. They can also cut training costs by providing a consistent interface across applications.

Power to the People

At $195, AlphaWorks 2.0 is both the most expensive and, probably, the most powerful product in the group.

AlphaWorks calls its individual modules "services"; it contains word processing, database, spreadsheet, and communications services. You can have up to nine of each of the first three services and two communications services active at one time, and you can switch among them. You can fill the screen with one, or split it into top and bottom windows that show two different services.

You start by choosing a service from a menu. Once you're in a service, you control it with a menu bar at the top of the screen; a status line at the bottom gives you information. You choose a menu by pressing the function key shown above its title or by pressing the slash key (/) to get to the menu bar. You move around there by using the left and right arrow keys. You pick choices from the menus with the up and down arrow keys. You can also use a mouse.

Some nice touches include the ability to print in the background, a keystroke macro facility, and on-line help. If you run short of memory, you can remove from memory such nice but nonessential tools as its spelling checker or thesaurus.

While the individual modules of AlphaWorks compare well with those of the other products in this group, this is the only product without any personal-information-management tools.

The AlphaWorks word processor limits documents to a maximum size of 64K bytes, or 2000 lines of up to 255 characters each. It has the usual basic functions, such as word wrap, support for different type styles (boldface, italic, subscript, and superscript), multiple rulers, headers and footers, and block moves. You can even move blocks of text among different word-service windows. You can also import and export both ASCII and DIF documents. The spelling checker has 100,000 words, and the thesaurus has 120,000 synonyms.

The spreadsheet resembles a subset of Lotus 1-2-3 release 2.0. It even stores its files in the 1-2-3 release 2.0 file format. It can also import and export DIF and ASCII files. It does not, however, support 1-2-3 macros or database functions.

Spreadsheets can have up to 8192 rows by 255 columns. There are more than 80 1-2-3-style functions. The spreadsheet can also recalculate large worksheets in the background. There is a reasonable assortment of graphs, including scatterplots and bar, stacked bar, line, pie, and exploding pie graphs.

With version 2.0, AlphaWorks' database service has become one of its strongest features. It stores data in the dBASE III Plus file format and offers over 50 dBASE functions. You can have as many records as your disk will hold, with up to 128 fields per record. A relational-style feature lets you link fields in two different files. You can even define dBASE-style memo fields of up to 64K bytes each. You are limited, however, to a maximum of seven indexes per database.

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The database lets you examine your data in the two classic views: forms and tables. A fill-in-the-blank Query By Example tool lets you find data easily. You can then present that data in customized forms and reports. As with the other main services, you can import and export data in either ASCII or DIF format. There is also a mail-merge facility.

AlphaWorks' communications service is one of the strongest of the group. It lets your DOS microcomputer emulate the DEC VT100 terminal and provides a good set of file transfer protocols: Kermit, XMODEM, XMODEM-CRC, and YMODEM. You can also transmit and capture ASCII files.

You can automate routine communication tasks with both a simple learn mode and a more powerful script language.

AlphaWorks is a solid product with many features. Its use of the Lotus 1-2-3 and dBASE III file formats is particularly convenient if you need to share data.

Serving Up the Works

Even though, at $149, Microsoft Works 2.0 is the second least expensive product here, in many ways it is the Cadillac of the group. It is polished and very easy to use, with a clear orientation toward the novice. At the same time, it has plenty of features. Microsoft Works is neither the most powerful nor the most complete product described here, but it is close on all counts.

Like AlphaWorks, Microsoft Works has a menu bar across the top of the screen and a status line across the bottom. You get to the menu bar by pressing Alt, and then you choose a menu by pressing the highlighted letter in the menu's name. You pick menu items in the same way. You can also use a mouse.

Works calls its modules "tools." You can have up to eight tool windows active at once. These windows offer a full set of control options, including resizing gadgets and scroll bars. All the windows, regardless of the tools in them, can display multiple fonts. You can also copy data among tools.

You get many of the general niceties characteristic of these products with Works, including on-line help and a keystroke macro facility. In the usual Microsoft style, there are extensive tutorials.

The star Works tool is, not surprisingly, its word processor, which resembles a watered-down Microsoft Word. It has all the standard word processing features, including word wrap, headers and footers, and support for the basic type styles. You can open up to eight files at once and move text among them. There is also a 100,000-word spelling checker and a thesaurus with 30,000 keywords that lead to 300,000 synonyms.

Works lets you dynamically link spreadsheet graphics to word processing documents; graphs in text change automatically when any of the underlying data changes. A mail-merge feature lets documents import database data.

You can import and export documents in both Microsoft Word and DCA (DisplayWrite) formats, but to do so, you must purchase the $5 Conversion and Supplemental Setup Kit—a nuisance that Microsoft should eliminate.

The two other main tools are not as strong. The spreadsheet can handle only 256 columns and 4096 rows, and there are only 50 functions. It uses a file format that is close enough to Lotus 1-2-3's .WKS that you can use its files in 1-2-3,

continued

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but there are some minor differences. You can import and export only delimited ASCII files.

The graphics options are better than the spreadsheet, with pie, exploded pie, bar, stacked bar, line, area, high-low, and scatter graphs, as well as graphs that use combinations of these styles.

The database tool shares the spreadsheet's limitations: a maximum of 4096 records of up to 256 fields each, with a maximum field size of 256 bytes. This low record limit makes the Works database tool suitable only for small jobs.

You can view the data in the standard form and table styles, and there is a simple report writer, as well. You can query data with expressions that use the usual comparison operators (e.g., =, < >, and <).

The Works communications tool is also limited, although it does offer VT100 emulation. It provides only one file transfer protocol, XMODEM, along with the ability to transfer ASCII files. Two nice features are a phone directory and a learn mode that lets you automate routine log-on procedures.

Unlike AlphaWorks, Microsoft Works provides several personal-information-management tools, including a calculator, an alarm clock, and an appointment manager. You can also perform many common DOS file management functions from within Works.

Works' real strengths are its word processor and its overall design, which is solid, easy to learn, and easy to use.

Choice Morsels

The $169 PFS:First Choice 3.01 package is probably the least powerful of the four discussed here, but it is also one of the easiest to use.

When you bring up PFS:First Choice, a main menu appears in the center of the screen. You choose a module (e.g., document, database, or spreadsheet) from that menu by moving a pointer to the item or by entering its number.

You control each of the major modules with the menu bar at the top of the screen. Each menu on the bar has a title and a function-key label that precedes the title. You can choose a menu by pressing that function key or by moving to it with the left and right arrow keys. You pick menu choices by using the up and down arrow keys or by entering the number of the choice. You can also use a mouse. Some of the nice features of this product are its keystroke macro facility, an on-line help system, and the ability to move data between its modules via a clipboard.

Unfortunately, the program is inconsistent in its menu structure, because the communications and disk-utility modules don't use a menu bar. Instead, they use center-of-the-screen menus that operate like the opening menu.

The First Choice word processor lets you copy blocks to and from the clipboard, as do the other modules. Document lines are limited to 250 characters, which should be adequate for most applications. You can define headers and footers, and you can have multiple rulers. There is also a mail-merge facility. The spelling checker has a reasonable 75,000 words, but its thesaurus contains only 20,000 keyword entries.

The word processor shines in its ability to import and export both external files and data from its other tools. It can handle files in almost every major word processor format, including WordPerfect, WordStar, MultiMate, Wang PC,

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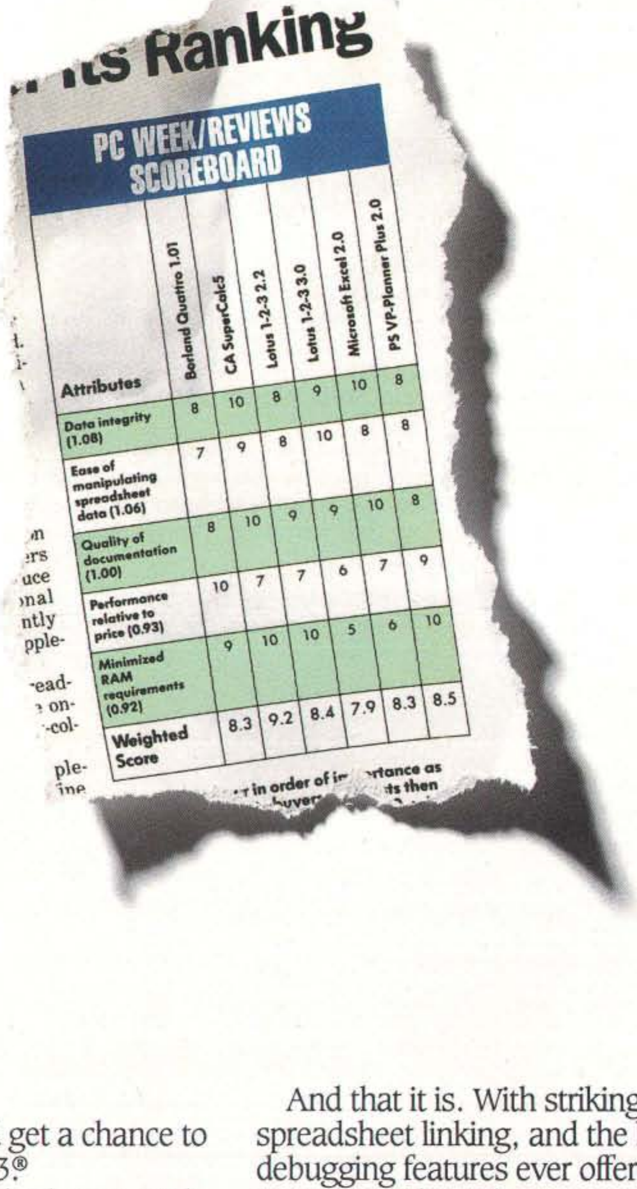

its Ranking

PC WEEK/REVIEWS SCOREBOARD

Attributes	Borland Quattro 1.01	CA SuperCalc5	Lotus 1-2-3 2.2	Lotus 1-2-3 3.0	Microsoft Excel 2.0	PS VP-Planner Plus 2.0
Data integrity (1.08)	8	10	8	9	10	8
Ease of manipulating spreadsheet data (1.06)	7	9	8	10	8	8
Quality of documentation (1.00)	8	10	9	9	10	8
Performance relative to price (0.93)	10	7	7	6	7	9
Minimized RAM requirements (0.92)	9	10	10	5	6	10
Weighted Score	8.3	9.2	8.4	7.9	8.3	8.5

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Microsoft Word, Professional Write, and DisplayWrite. You can include graphs, charts, tables, and even whole spreadsheets all in the same document.

Like Works, PFS:First Choice handles only small spreadsheets—you're limited to 1024 rows and 768 columns. One nice touch, however, is a percentage indicator that lets you know how much of the available space you've used. This spreadsheet offers more functions (70) than the one in Works, but fewer than the one in AlphaWorks. You can import and export spreadsheet data in 1-2-3 release 1A and 2.0 formats, as well as in ASCII.

The spreadsheet's strengths are in its graphics capabilities, which is perhaps not surprising, given that Software Publishing also sells the Harvard Graphics products. In fact, PFS:First Choice lets you import and export graphs in the Harvard Graphics and Harvard Presentation Graphics formats. You can also define bar, stacked bar, overlapping bar, line, point, scatter, area, and pie graphs, as well as combinations of those styles. A presentation graphics facility lets you assemble slide shows of these graphs.

Unlike its spreadsheets, PFS:First Choice's databases are limited only by the amount of disk space available—a number that you can monitor with the percentage-full indicator. You can design customized forms and reports, as well as view data in both form and table styles. The only import and export formats, however, are delimited and fixed-length ASCII.

PFS:First Choice's communications module has the same major features as the one in Works. It has only one file transfer protocol, XMODEM, and it can transfer ASCII files. There is also a phone directory and a facility for defining automatic sign-on procedures.

The program also offers two main personal-information-management tools, a calculator and a set of disk utilities.

The primary strengths of PFS:First Choice are its strong graphics and its ability to export and import many different word processor formats.

Eight Is Enough

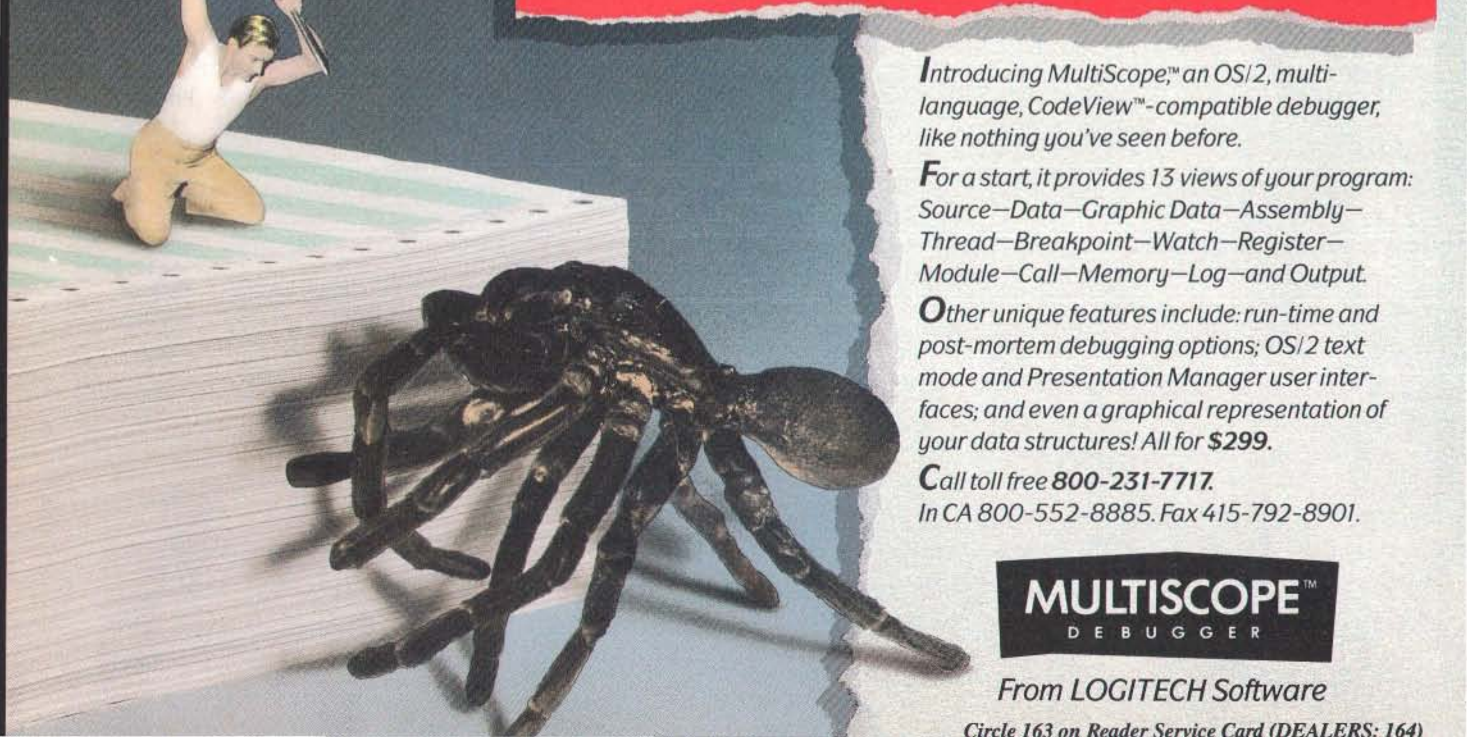
Surprisingly, the least-expensive product here, the $60 BetterWorking Eight-in-One 2.0, has most of the features of the others, as well as a few that they lack. It's a bit rougher than the rest, though. Its modules, for example, are not as well integrated as those of the other products.

You control Eight-in-One with the typical menu bar. Its status line is above that bar. You get to the menu bar by pressing the Escape key. Once there, you can pick a menu by entering its first letter or by using the left and right arrow keys and pressing Enter. You pick menu options either by using the up and down arrow keys or by pressing the first letter of the option. You can also use a mouse. Should you need it, there is the usual online help system.

Eight-in-One's word processor limits documents only by the amount of memory in the system. On a 640K-byte machine, the limit will typically be 50 pages or less, depending on the density of those pages and the number of type styles in them. The word processor supports boldface, underlined, enhanced, double-wide, and compressed characters, all of which consume more memory than plain characters.

You can edit two documents at once and copy text blocks between them. In

continued



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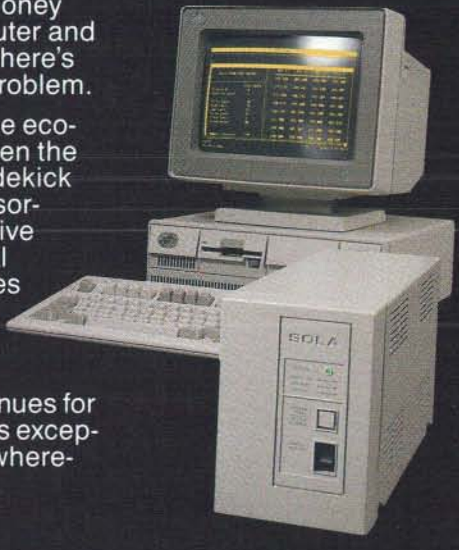

addition to such standard features as headers and footers, there is a word-count option, something that writers everywhere will appreciate. There is also a mail-merge facility. In addition to a 100,000-word spelling checker and a 60,000-synonym thesaurus, Eight-in-One also has a separate outliner module.

The spreadsheet module, like the word processor, is limited only by the amount of available memory. It has a theoretical maximum of over 10,000 columns and 32,768 rows; on a 640K-byte microcomputer, you can get between 3000 and 4000 cells. (The exact number depends on what's in those cells; formulas, for instance, use more memory than data.)

In most other ways, the spreadsheet is one of Eight-in-One's weakest modules. In earlier versions of the product, the spreadsheet was very slow, but this version runs significantly faster. Also, it now recalculates only the minimum number of cells necessary. Unfortunately, the spreadsheet still offers under 50 functions, the fewest in the group. It can import and export files in Lotus 1-2-3 and DIF formats, and it can read 1-2-3 WK1 files directly.

Eight-in-One has reasonable graphics options, including pie, exploded-pie, bar, hatched-bar, line, and shaded-line graphs. The graphics module, however, is separate from the spreadsheet. To make a graph, you must first import spreadsheet or database data.

The database module is a simple, flat-file manager that can handle up to about 20,000 records of up to 128 fields each. Each field can hold a maximum of 254 characters, although you can define memo fields for larger text chunks. There are over 30 database functions, as well as a simple report generator. You can import and export only ASCII files.

The communications module is also simple. There are no file transfer protocols; you can only upload and capture ASCII files. It can, however, emulate more terminals—IBM 3101, TeleVideo 920, and VT100—than the other products. In addition to a keyboard macro facility that lets you automate log-on procedures, there is a phone directory and a chat mode that lets you hold typed "conversations" with other computers.

One of Eight-in-One's strengths is its set of personal-information-management tools. Its desktop organizer has many of the features of Borland's SideKick, including a to-do list, a memo pad, an address book, an automatic dialer, a label maker, and a memory-resident calendar.

Backing the Right Horse

For basic word processing, spreadsheet, and database functions, you won't go wrong with any of these products. We've noted some of the strengths of each, but none stands out clearly as the best.

If word processing is your primary concern, go with Works. For the best graphics, check out PFS:First Choice. BetterWorking Eight-in-One is the obvious budget winner. And, for all-around power, we suggest AlphaWorks.

Integrated software packages clearly offer an advantage for those on a budget. They cram a lot of features into a small space—for a small price. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.

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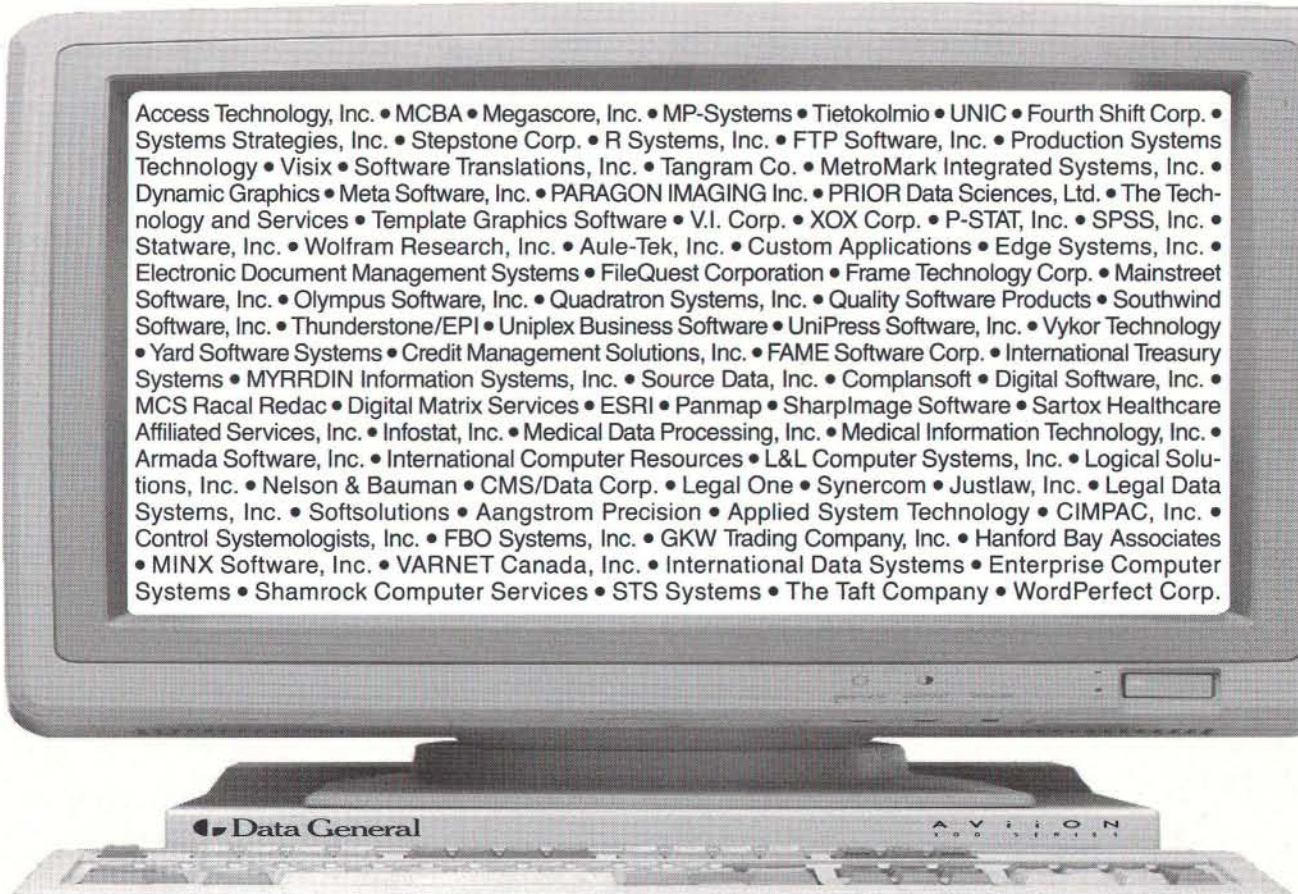

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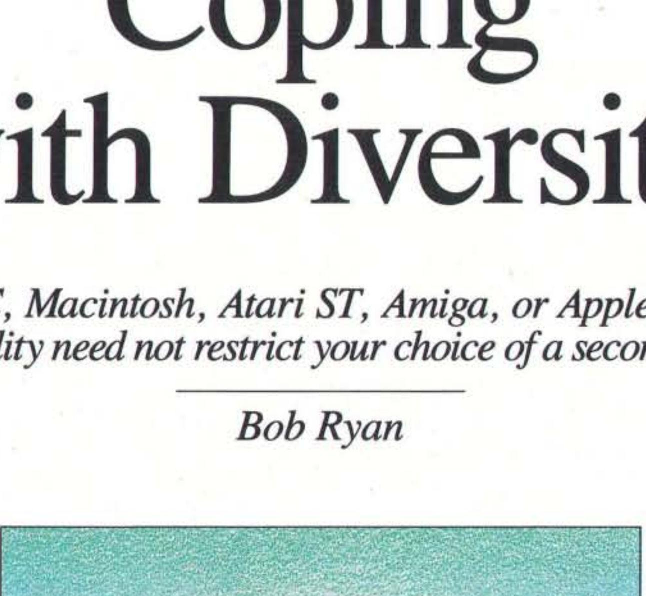
Coping with Diversity

IBM PC, Macintosh, Atari ST, Amiga, or Apple IIGS—incompatibility need not restrict your choice of a second computer

Bob Ryan



The computer industry pays a lot of attention to compatibility—perhaps too much. The fact is, no one computer architecture or operating system can be all things to all users. This becomes evident when you consider purchasing a computer for a specific task, such as creating presentations for your business or providing a home computer for your family. Ideally, you'd like to have a computer that is compatible with the DOS machines you use at work, but you'd also like to address specialized areas that are not best served by a DOS machine (e.g., desktop video, education, or music). What do you do?

Most likely, you'll make a choice between compatibility with your office computer and applicability to your other pursuits. You won't have to make such a choice, however, if you replace the requirement for compatibility with one that emphasizes *interoperability*.

Tripping the Tongue Fantastic

Interoperability describes the exchange of data between computers that have different architectures or are running under different operating systems. In practice, it means being able to transfer files between different types of machines, and being able to *use* the files on both. Thus, if you could transfer files between your office computer and your home computer, you might not be restricted to a home machine that is compatible with your computer at work.

There are different levels of interoperability—from simple text transfers to hardware emulations—that let you work with the same data on different computers. The solutions discussed here apply to any situation that demands interoperability, from sharing data between adjacent computers in the office to taking data from work to be massaged by a home computer.

Exchange Limits

While you can transfer just about any file between any two computers, the types of files you can *usefully* exchange is more limited. Of course, transferring executable files from one architecture to another is fruitless unless you have some form of emulation that lets the second computer use software written for the first. Emulations do exist (see the text box "Out of One, Many" on page 258). But, for the most part, the objective is to transfer data files from one machine to another in a format that both the operating system and an application program running on the target machine can use.

Making a Connection

The most common mode of data exchange between dissimilar computers is

continued

ILLUSTRATION: DAVE CALVER © 1990

Out of One, Many

So you really need strong compatibility between your office machine and your home computer, but still want the advantages of an Atari ST or an Apple IIGS at home. Don't despair; you have options that don't involve buying another computer system.

Emulators are software or hardware products that let you run software written for one computer on a completely different computer. Emulators have been around for at least a decade, although their history is a bit checkered.

For example, in the early 1980s, Rana Systems brought out a hardware emulator that let you run DOS software on an Apple II. The problem was that the emulator cost nearly as much as a stand-alone IBM system. Rana Systems, which had had a bit of success selling replacements for Apple II disk drives, did not survive its foray into hardware emulation. Other examples of failed hardware emulators, from the Dimension 68000 to MacCharlie, litter the byways of the personal computer world.

The Beat Goes On

Because it is such a compelling idea, emulation didn't die along with these early implementations. Today, you can buy hardware and software emulators that let you run DOS, Macintosh, even Commodore 64 software on different hardware platforms. I will concentrate on some of the hardware emulators because, although they are more expensive than software emulators, they invariably perform better and provide better compatibility.

Today, you can successfully run DOS software on an Apple II, Macintosh, Atari ST, or Amiga, and Mac software on an Amiga or Atari ST. Often, it's not the software that proves incompatible, but the hardware. For instance, you may not be able to access all the I/O ports (e.g., mouse, disk drive, parallel, and serial) on your machine from the emulator. Check the specifics of each emulator before you buy one.

PC on a Card

Because DOS has the largest installed base of any microcomputer operating system, it's a natural target for hardware emulation. If you own a Mac II, you can emulate a PC AT with the Mac286 from Orange Micro. If you own an Apple IIGS, you can emulate a PC XT by installing the PC Transporter from Applied Engineering. Both of these emulators are "computers on a card" that plug into expansion slots on their respective machines and let you run a wide variety of DOS software, often at speeds exceeding that of the emulated machine. PC Speed from Michtron provides DOS compatibility for the Atari ST.

Commodore has gone one step further in its emulations of AT (the A2086 board) and XT (the A2088) computers. Commodore's Amiga 2000 contains a four-slot AT bus on its motherboard, in addition to its Amiga Zorro slots. The emulator boards sit in both an AT slot and a Zorro slot. You can use the extra AT slots for IBM peripheral cards, thus providing expansion compatibility as well as software compatibility.

The Amiga 2000 with an IBM emulator has another interesting feature. Because the Amiga operating system is multitasking and the IBM emulator runs from an Amiga task (see figure A), you can run AmigaDOS and DOS programs concurrently and even cut and paste between the two.

All in the Family

While these DOS emulations, in effect, put a computer, complete with microprocessor, on a card (or two), many emulations need not be so extensive. Two examples are Spectre GCR, from Gadgets by Small, for the Atari ST, and ReadySoft's A-Max for the Amiga. Both of these products let you run Macintosh software on these machines. The emulators themselves are not as extensive as the DOS ones because the Amiga and the Atari ST use the same microprocessor as the low-end Macintoshes—the MC68000. Therefore, they can use their own processors to execute the Macintosh instructions.

What both of these emulators lack are the Macintosh ROMs. If you buy A-Max or Spectre GCR, you will have to buy Macintosh ROMs and plug them into the emulator. The fact that Apple's legal department has not taken action against the emulators seems to indicate that the emulators don't step on anyone's copyrights or patents. Atari, in fact, indicated at Fall Comdex 1989 that it considers the combination of its portable ST, the Stacy, and Spectre GCR to be a viable alternative to the Mac Portable.

One-Way Street

Most emulators enable those machines with a smaller installed base to run software written for DOS and Macintosh computers. Thus, you have the Amiga emulating the AT or the Mac, but not the reverse. By virtue of their larger installed bases, DOS machines and Macs have many more software packages available than the Amiga does. Since one of the prime reasons for an emulator is to tap into a larger base of software, there is little motivation for an AT to emulate an Amiga.

Amiga, Apple II, and Atari machines each have areas in which they excel. Emulation can give you the best of both worlds: compatibility with your primary computer and the advantages of an alternative architecture.

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a serial connection; it can be either direct or remote. The advantage of a serial connection is that you don't have to worry about disk formats. A Mac file sent via a serial connection to a DOS machine is saved on the target machine in DOS format.

With a direct connection, you hook up the two computers with a null-modem cable, load communications software on each, and transfer files at will. The advantage of this method over indirect methods is that you can transfer data at much higher baud rates than you can using a modem. The disadvantage is that the computers have to be at the same location. Thus, direct connections are best for transfer between two office computers. They will not help you with home-office transfers.

Many companies offer products that provide both the software and hardware for direct file transfers. Traveling Software, for example, sells LapLink-Mac for high-speed file transfers between DOS machines and Macintoshes.

Indirect methods involve using a modem. Although transfer rates are slower using a modem, the computers involved can be miles apart.

You have two choices in modem transfers. You can have one computer call the other directly, or you can use an inter-

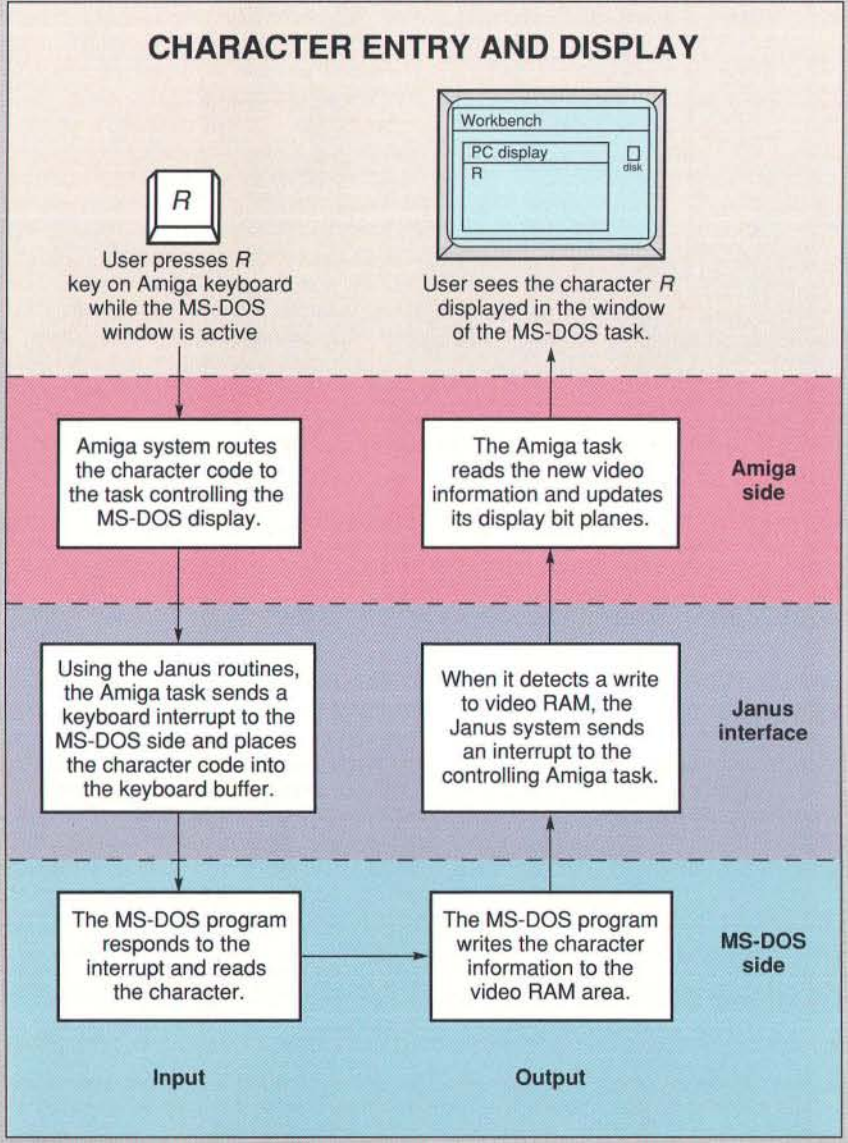

CHARACTER ENTRY AND DISPLAY
R
User presses R key on Amiga keyboard while the MS-DOS window is active
Workbench
PC display
R
disk
User sees the character R displayed in the window of the MS-DOS task.
Amiga system routes the character code to the task controlling the MS-DOS display.
The Amiga task reads the new video information and updates its display bit planes.
Amiga side
Using the Janus routines, the Amiga task sends a keyboard interrupt to the MS-DOS side and places the character code into the keyboard buffer.
When it detects a write to video RAM, the Janus system sends an interrupt to the controlling Amiga task.
Janus interface
The MS-DOS program responds to the interrupt and reads the character.
The MS-DOS program writes the character information to the video RAM area.
MS-DOS side
Input
Output

Figure A: *The Janus interface between the DOS board on an Amiga 2000 and the controlling Amiga task sends keyboard input to the DOS side and makes the DOS video RAM accessible to the Amiga output system.*

mediary, such as BIX or CompuServe. The first option works only if you have communications software for one computer that allows it to operate unattended. The second option is much more common for home-office transfers. While you're at work, you access your account on the information service and upload the data. Then, when you get home, you download the data using your home computer.

The Data Disk Exchange

Another common method of data exchange involves direct disk access. Although it's not possible under normal circumstances for one operating system to read and write to data disks formatted by another, specialized software and hardware are often available to provide this capability. Because DOS is the most popular microcomputer operating system, most of these specialized products are designed to allow non-DOS computers to read DOS disks.

For example, a utility for the Amiga called CrossDOS, from Consultron, lets you access DOS, as well as Atari ST, disks from the Amiga. It works with the standard Amiga 3½-inch drives.

The Apple SuperDrive, standard on upper-end Macintosh computers (and available as an external option for other Macintoshes) lets you transparently access Macintosh disks with the Apple IIGS and vice versa. More important, however, by using a special utility from Apple, you can access DOS-formatted disks placed in the SuperDrive.

The Atari ST provides the simplest method of direct file exchange with DOS. Since the ST disk format is nearly identical to the DOS format, you can read and write to DOS disks with an Atari ST disk drive. Conversely, you can read and write to Atari ST disks with a DOS computer.

Of course, any disk you plan to use on two different machines must be in a format that the drives on both machines can handle. There are restrictions on the formats that some systems can handle. For example, CrossDOS for the Amiga can read 720K-byte DOS disks but not 1.44-megabyte disks. The standard Amiga disk drives are unable to handle the higher density.

In this age of heterogeneous LANs, you may also have access to another transfer technique. For example, many LANs provide a gateway to AppleTalk. With such a system, you can easily transfer a file from a DOS machine on the LAN to a Macintosh or IIGS located on the AppleTalk network. NetWare for Macintosh from Novell is an example of such a gateway (see figure 1).

Format Blues

It's not difficult, then, to move a file between computers that are based on dissimilar architectures. File transfer, however, is only half of the interoperability picture. You have to be able to use the files after you transfer them. Having a file in the proper disk format doesn't ensure that it's in the proper file format for your application.

The simplest file format, and the one that is most commonly used in transfers between different computers, is ASCII (or text) format. Most word processors and many other types of application programs can read and write to ASCII files. The only problem that you are likely to encounter is with the end-of-line character.

continued

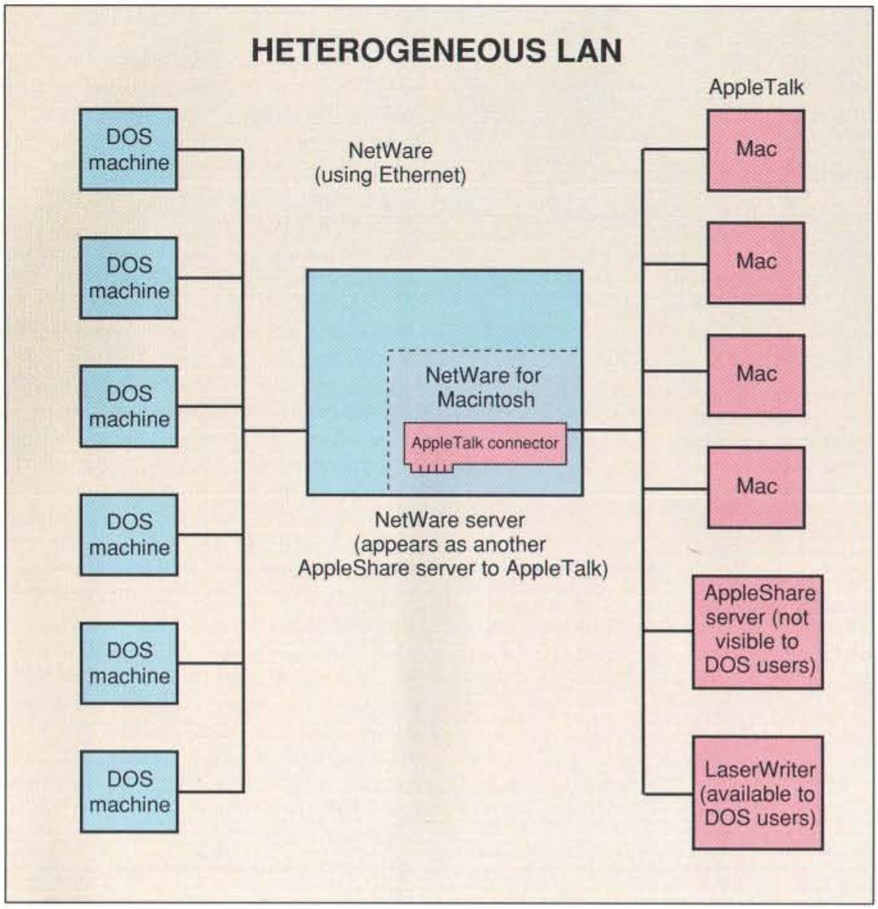


Figure 1: *NetWare for Macintosh is a NetWare process that communicates with AppleTalk via an AppleTalk connector. The gateway lets DOS users access AppleTalk printers and AppleTalk users access the NetWare server.*

Different applications and operating systems use different end-of-line characters. Some use carriage returns, others use linefeeds, and still others use a combination of the two. The problem is that if you load an ASCII file with one type of end-of-line indicator into a word processor that uses another, you can get unexpected results.

Thus, you may want a utility to strip or add carriage returns or linefeeds. Fixup is a public domain utility for the Macintosh that can strip linefeeds and carriage returns from a file, or convert one to the other. Another Mac utility, a shareware program called Macify, lets you perform all sorts of transformations and conversions on text files. Other systems have similar utilities available (e.g., Strips for the Atari ST and CR for DOS).

Converting text files is important for many applications, especially word processing, but text file transfers have limited utility. For one thing, the files lose most of their original formatting in the transfer.

Picture Perfect

Although you can easily transfer graphics data from one machine to another, you will need specialized conversion utilities to convert it into a format that the target machine can use. For example, SHRConvert for the Apple IIGS lets you load and view Amiga, Atari ST, and Macintosh picture files and save them in IIGS-compatible format. Picswitch for the Atari ST does the same thing with Macintosh and Amiga files, while Macview (for Macintosh pictures) and AmGIF (for GIF files) provide this function on the Amiga.

These file converters and others are available as public domain and shareware programs. More powerful conversion utilities are available from commercial software sources. For example, MacLinkPlus/Translators from DataViz performs 76 specific DOS-to-Mac and 76 Mac-to-DOS conversions. As computers become more graphics oriented, the need for graphics-conversion utilities will increase.

Miraculous Conversions

Although the explicit conversion of files from one format to another is often necessary, it isn't the most convenient route to take. The best route is implicit conversion, where the application does the conversion for you. In other words, the applications you use load and convert file formats automatically.

Many word processors and spreadsheets let you load and save files created by other programs. Many spreadsheets and database programs also support the DIF format, a specialized text file format that is useful for transferring text data in a row-and-column format. DIF files, however, cannot contain formatting information.

Of course, the situation is even easier if you're using the same program on two different computers. However, it's not always easy to find a product that runs on the particular computers you have. For example, only one major application, WordPerfect, runs on all five of the computer systems highlighted here. While there are many applications that span the Mac/DOS gap, only a few of these are also available on the Atari ST, Apple IIGS, or Amiga.

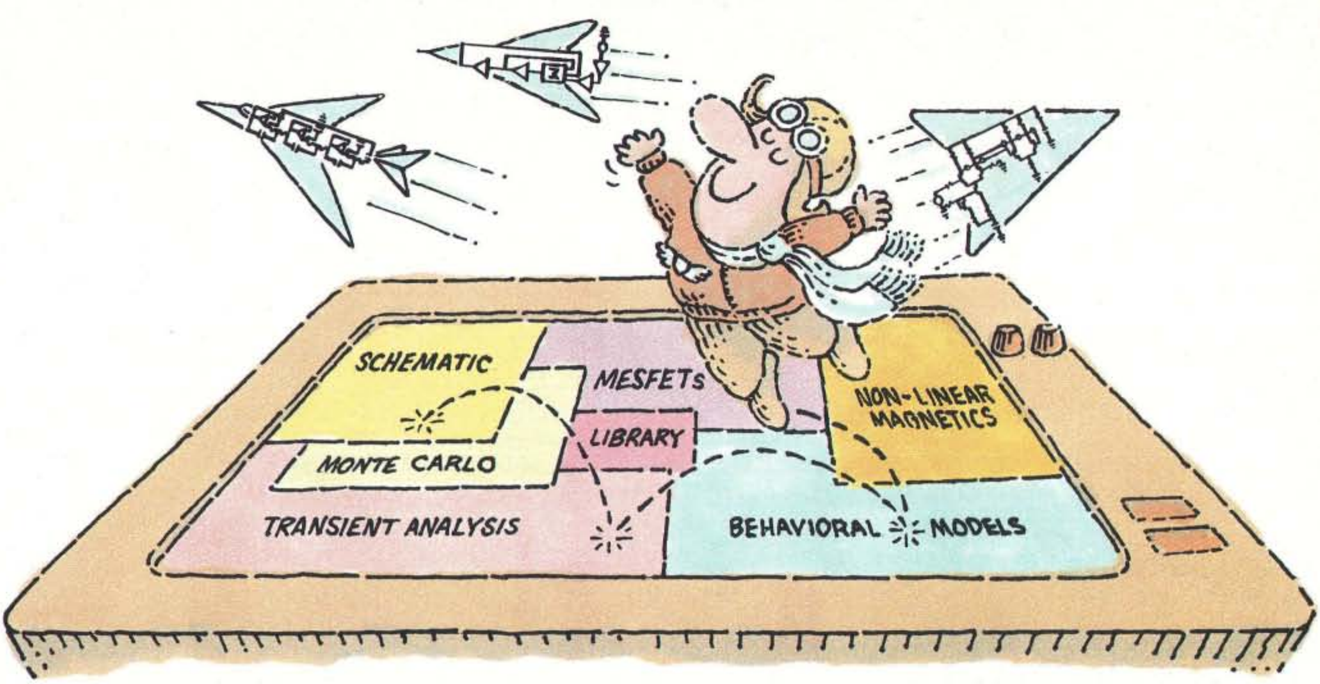
The fact that most ST, IIGS, and Amiga developers are smaller and have less clout than the major DOS and Mac software companies makes it imperative that they provide for the import and export of files created by DOS and Mac applications. While the ST, IIGS, and Amiga all have areas where they surpass the capabilities of the more popular business machines, the onus of providing interoperability with major business applications falls on them.

The Payoff

Interoperability is not an ideal solution; in fact, it is often a frustrating process. You may have to dig deep to find conversion utilities or applications to match your needs. In some cases, the necessary utilities and applications may not yet exist.

So why bother? Because, in the long run, interoperability greatly expands your computing options. Imagine being able to take advantage of the MIDI capabilities of the Atari ST, the video and animation power of the Amiga, or the educational software available for the Apple IIGS—without sacrificing the ability to bring work home. Incompatibility does not have to be an obstacle; it can be an opportunity. ■

Bob Ryan is a BYTE technical editor. You can reach him on BIX as "b.ryan."



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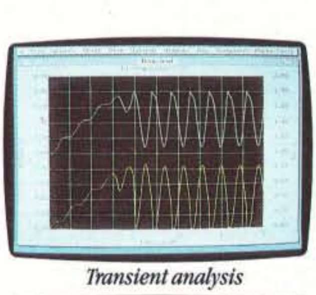
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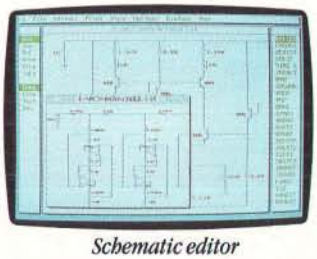
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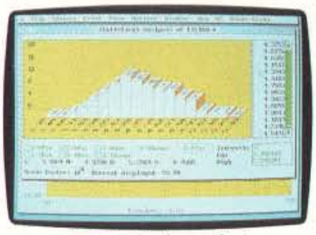
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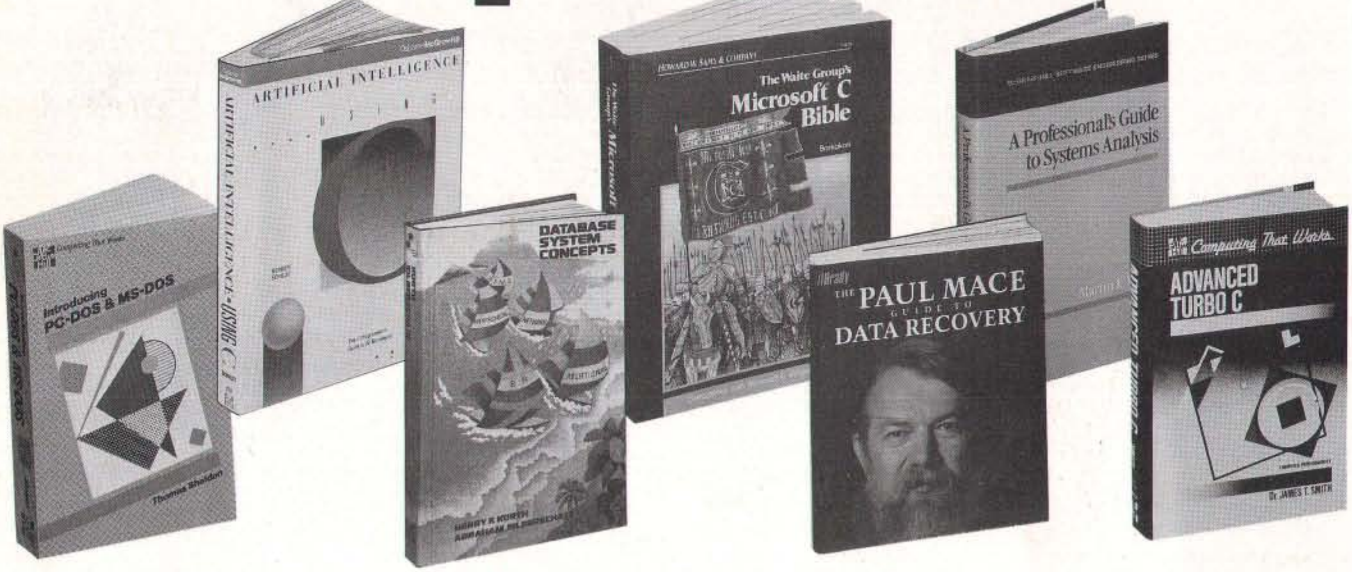
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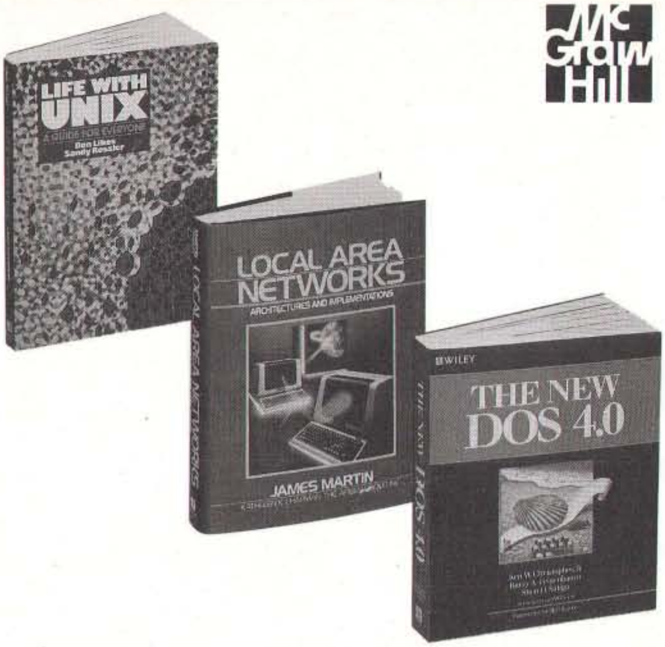

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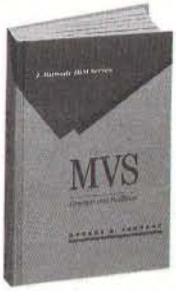

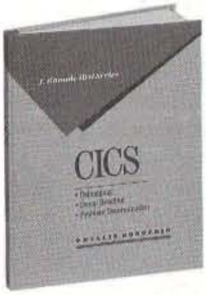

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THE SPIRIT OF '86S

Rooted in PC compatibility, the Intel family tree has flourished, but a few competitive offshoots are taking root

Frank Hayes

Nine years ago, IBM introduced the original PC with its Intel 8088 CPU. *IBM PC-compatible* has since become a household word, and CPUs that can run IBM PC-compatible software have proliferated—not just from Intel, but from other chip makers as well. That situation, in turn, has led to squabbles, sniping, and outright legal warfare among the half-dozen companies that make these CPUs (see "Battle of the Chips," March 1989 BYTE).

But in spite of the plethora of Intel-compatible chips and conflicting claims, the family isn't as hard to get a handle on as you might think. Even with hot new chips like Intel's i486 (and promised future versions, including the i586 and i686), there are really only three major varieties of CPUs in PC-compatible desktop computers (see table 1). Which flavor should power the machine on your desk? That depends on what you need, how you'll use it, and how much you have to spend.

The Soul of a PC Machine

The most popular group of PC-compatible CPUs is still the original. Intel launched its 8088 CPU in 1978, and it became the brains for the IBM PC and XT. After a decade, the 8088 was no longer a big seller for Intel, but as many as half of all PCs sold today still run off an 8088-compatible chip. How is that possible? Just as there are plenty of PC clones on the market, there are lots of 8088 clones as well.

In fact, the original 8088 wasn't original at all. Intel's first version of the chip was the 8086—the company's first 16-bit CPU. The 8086 had a 16-bit data bus and could address up to 1 megabyte of memory with a 20-bit address bus. (By comparison, the chips that Intel was selling for desktop computers at the time, the 8080 and 8085, each had an 8-bit data bus and a 16-bit address bus and were limited to 64K bytes of memory.)

The 8088 was a low-end version of the 8086. Although it could address up to 1 megabyte of memory, the 8088 had only an 8-bit data bus. (In fact, Intel originally described the 8088 as an 8-bit CPU; only when IBM selected the chip for its original PC did anyone start calling it a 16-bit CPU.)

Except for the difference in data-bus width, the two CPUs were virtually identical, although because of its extra speed in accessing data, the 8086 is somewhat faster when the two chips are operating at the same clock speed. The original IBM PC used an 8088 CPU running at 4.77 MHz—the slowest CPU in the line. Today, Intel sells 8088s with a clock speed of up to 8 MHz, and 8086s with a clock speed of up to 10 MHz.

In 1982, Intel introduced an enhanced version of the 8086—the 80186. Like the 8086, it has a 16-bit data bus and can address 1 megabyte of memory. The 80186 runs all 8088/8086 software, but it adds 10 new instructions. It also includes some special features, including an on-board clock and DMA channels—and it runs about 25 percent faster than an 8086 running at the same clock speed.

Like the 8086, the 80186 runs at up to 16 MHz. And like the 8086, there's a low-end version, the 80188, with an 8-bit data bus (and slightly slower performance because of it). But unlike the 8086 and 8088, the 80186 never made it big in the PC world. IBM didn't use the 80186 in any of its computers, and the few machines that did use the chip quickly faded from view. Today, though, it's finding new life as an embedded controller on Extended Industry Standard Architecture and Micro Channel add-in cards.

80286: The Next Generation

The next major upgrade after the 8088-compatible CPU was the Intel 80286. The 80286, which was the CPU that IBM chose for its AT computer, was the first 8086-compatible chip that included multitasking instructions. The 80286 can run all 8088 software and, unlike its predecessors, can address up to 16 megabytes of memory with its 24-bit address bus.

The 80286 also offers new instructions and a special "protected mode" that allows switching among several different concurrently running programs. When Microsoft and IBM began working on OS/2, a next-generation multitasking operating

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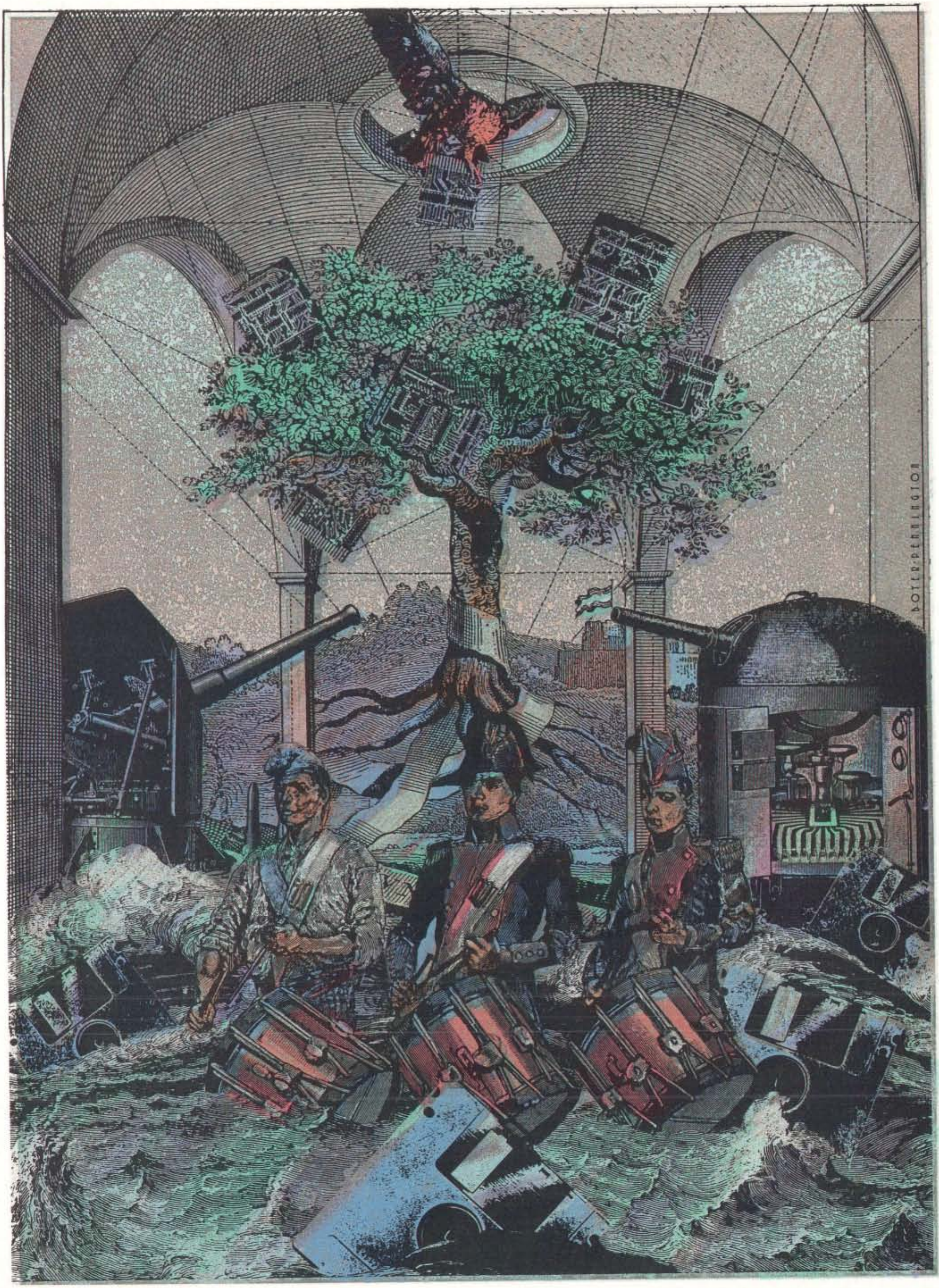

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system that would push past the limitations of DOS, they designed it for the 80286.

Unfortunately, those multitasking features did not work quite as well as Intel originally planned. The problem showed up when switching between the 80286's real mode and protected mode. DOS programs would run properly under real mode, but switching between DOS programs required going to protected mode. But because of the placement of bits in the 80286's segment register, as soon as the CPU switched to protected mode, DOS programs would crash.

Programmers, including Microsoft's OS/2 programming team, had to write special code circumventing the hardware task switching, and the result was unsatisfactory multitasking performance. Although current versions of OS/2 will run on an 80286-based PC, future versions will require an 80386 CPU or higher.

IBM PC–COMPATIBLE CPUS

Table 1: IBM PC–compatible CPUs fall into three general categories: 8088-compatible CPUs (IBM XT), 80286 CPUs (IBM AT), and 80386/i486 CPUs.

Chip name	Maker	Bus specs	Address space	Maximum clock speed	Typical use
Group 1					
8088	Intel	8-bit data 16-bit internal	20-bit address (1 megabyte)	8 MHz	Low-end, single-user PCs, especially portables
8086	Intel	16-bit data 16-bit internal	20-bit address (1 megabyte)	16 MHz	Low-end, single-user PCs, especially portables
80188	Intel	8-bit data 16-bit internal	20-bit address (1 megabyte)	16 MHz	Embedded controller
80186	Intel	16-bit data 16-bit internal	20-bit address (1 megabyte)	16 MHz	Embedded controller
V20	NEC	8-bit data 16-bit internal	20-bit address (1 megabyte)	10 MHz	Low-end, single-user PCs, especially portables
V30	NEC	16-bit data 16-bit internal	20-bit address (1 megabyte)	10 MHz	Low-end, single-user PCs, especially portables
V25	NEC	8-bit data 16-bit internal	20-bit address (1 megabyte)	8 MHz	Embedded controller
V35	NEC	16-bit data 16-bit internal	20-bit address (1 megabyte)	8 MHz	Embedded controller
V40	NEC	8-bit data 16-bit internal	20-bit address (1 megabyte)	10 MHz	Embedded controller
V50	NEC	16-bit data 16-bit internal	20-bit address (1 megabyte)	10 MHz	Embedded controller
V33	NEC	16-bit data 16-bit internal	24-bit address (16 megabytes)	16 MHz	Single-user PCs (not 80286/386/i486-compatible)
V53	NEC	16-bit data 16-bit internal	24-bit address (16 megabytes)	16 MHz	Embedded controller
V60	NEC	16-bit data 32-bit internal	32-bit address (4 gigabytes)	16 MHz	Single-user PCs (not 80286/386/i486-compatible)
V70	NEC	32-bit data 32-bit internal	32-bit address (4 gigabytes)	20 MHz	Single-user PCs (not 80286/386/i486-compatible)
V80	NEC	32-bit data 32-bit internal	32-bit address (4 gigabytes)	33 MHz	Single-user PCs (not 80286/386/i486-compatible)
Group 2					
80286	Intel	16-bit data 16-bit internal	24-bit address (16 megabytes)	12 MHz	Single-tasking or multitasking PCs
80286	AMD	16-bit data 16-bit internal	24-bit address (16 megabytes)	16 MHz	Single-tasking or multitasking PCs
80286	Harris	16-bit data 16-bit internal	24-bit address (16 megabytes)	25 MHz	Single-tasking or multitasking PCs
Group 3					
80386SX	Intel	16-bit data 32-bit internal	32-bit address (4 gigabytes)	16 MHz	Single-tasking or multitasking PCs
80386	Intel	32-bit data 32-bit internal	32-bit address (4 gigabytes)	33 MHz	Single-tasking or multitasking PCs
i486	Intel	32-bit data 32-bit internal	32-bit address (4 gigabytes)	25 MHz	Single-tasking or multitasking PCs

An i486 blows the doors off the 80386 when it comes to heavy-duty number crunching.

Because of its problems with multitasking, the 80286 is commonly used as a fast version of the 8088. And it is very fast indeed. Running software at the same clock speed, an 80286 is roughly 2½ times as fast as an 8086. And the 80286's clock speed has risen steadily over the years. The Intel version topped out at 12 MHz, but other chip makers who build 80286s under license from Intel, including Advanced Micro Devices and Harris Semiconductor, have continued to build faster versions. AMD's fastest version is currently 16 MHz, and Harris recently introduced a 25-MHz version of the chip. (AMD plans to introduce a 25-MHz version this year.)

Just how fast is a 25-MHz 80286? At that speed, an 80286 runs DOS software about 12 times as fast as an original 4.77-MHz IBM PC. It also runs that software slightly faster than a 25-MHz 80386-based PC. In fact, for DOS software it's faster than anything but a 33-MHz 80386 or a 25-MHz i486. As a result, it's estimated that up to 40 percent of the PCs sold last year were based on the 80286.

It's tempting to include the NEC V33 and V53 in the same category as the 80286. Like the 80286, the V33 and V53 can address up to 16 megabytes of memory, and they run at speeds of up to 16 MHz. But these NEC chips handle the extra memory differently than an 80286, and they're not plug-compatible with the Intel, AMD, and Harris versions.

32 Bits and Counting

The third category of 8088-compatible CPUs is the Intel 80386—with the emphasis on *Intel.* When it created its new line of chips, Intel changed two things that corrected the 80286's problems with task switching.

First, Intel saw to it that the 80386's task switching worked correctly, making possible a whole new range of multitasking software. Second, Intel decided that, this time around, it wouldn't share the golden goose. Unlike the earlier chips in the line, the 80386 is sold exclusively by Intel. (IBM reportedly has a license to make the chips, but only for use in its own machines.)

A few other fundamental differences set the 80386 apart. It is a true 32-bit CPU with an extended register set (all earlier Intel CPUs are limited to a 16-bit register set), it has a 32-bit data bus, and it has a 32-bit address bus that can directly address up to 4 gigabytes of memory—256 times the size of the 80286's address space. With multitasking that works, you can carve that memory up into separate "virtual 8086s," each of which appears to the software to be a real 8086 with its own 1-megabyte address space. In its native mode, the 80386 can also make direct use of the full address space.

The 80386 is much better at task switching than the 80286. The newest version of OS/2 is designed to take advantage of the 80386's improved multitasking, and it makes use of those improvements—including the ability to run multiple DOS programs at the same time. However, the 80386 remains something of a design trade-off between the ability to run 8088 software and the ability to do multitasking. Nonmultitasking DOS software runs no faster on an 80386 than on an 80286 at the same clock speed, and in some cases it actually runs slower. However, the 80386 has the ability to run at speeds of up to 33 MHz.

There's also a version of the 80386 with only a 16-bit data bus—the 80386SX. Because of the narrower data bus, the 80386SX is slower than a regular 80386 running at the same clock speed. (Intel recently began referring to the full-size 80386 as the 80386DX, to contrast it with the SX.) The 80386SX is also limited to a 16-MHz clock speed, although a 20-MHz version is expected soon.

The Intel i486 makes no such compromises. It is an enhanced version of the 80386 that includes its own coprocessor for performing floating-point operations, an on-board cache, and pipelined instruction execution. (Earlier chips used separate coprocessors. See the text box "Successful FLOPS" on page 270.) Theoretically, the i486 was designed to be completely compatible with the 80386, but in practice there are a few minor differences.

The i486 runs significantly faster than an 80386—about 40 percent faster at the same clock speed—and programmers can squeeze an extra 10 percent to 15 percent performance out of the i486 by using a compiler that optimizes instruction ordering for the i486's pipelining system. As a result, a 25-MHz i486 runs as fast as or faster than a 33-MHz 80386. The i486 also has a spectacularly fast FPU built in, a feature that makes it a better choice for number crunching than even the fastest 80386. The i486 runs at 25 MHz, with a 33-MHz version expected by the end of this year.

In fact, i486-based machines may soon provide the best cost/performance of any PC-compatible computers. The i486, which includes its own FPU and on-board cache, costs about the same as a 33-MHz 80386, an 80387 FPU, and a cache controller. But an i486 blows the doors off that same 80386, as well as anything else, when it comes to heavy-duty number crunching (see table 2). And the promised 33-MHz version will be 30 percent faster still.

Trouble in Paradise

Intel has vowed that, with the 80386 line, it's finally got it right. The company says it doesn't plan major design changes for its CPU line before the year 2000, so software written for the 8088, 80286, and 80386 should run on all compatible CPUs that Intel introduces for the next 10 years.

If that claim sounds like paradise for those making software decisions, it may be; there's no danger that Intel will suddenly make your version of Lotus 1-2-3 incompatible with its CPUs.

continued

LOW-LEVEL BENCHMARKS

Table 2: A comparison of the low-level benchmarks for some typical systems using four of the major current chips. Note that the 33-MHz 80386 is roughly comparable to the 25-MHz 486 machines.

	Dell 200 286	ALR FlexCache 33/386	Compaq 386s 386SX	IBM 70/A21 i486	Apricot i486
CPU	1.60	6.74	1.86	5.29	6.69
FPU	1.72	15.66	5.03	21.39	21.77

Indexes show relative performance; for all indexes, an 8-MHz IBM AT = 1.

Successful FLOPS

While CPUs have been progressing from 8088 to 80286 to 80386 and i486, the numeric coprocessors (FPUs) for the 80x86 line have progressed as well. Unlike some earlier numeric coprocessors, the Intel 80x87 FPUs actually work as extensions of the CPUs. The 8087 instructions, for example, are defined as part of the 8086 instruction set, and the two processors can exchange control of the data and address buses. In fact, the 8087 monitors and decodes instructions in parallel with the 8086.

This tight coupling of floating-point functions makes the 80x87 FPUs very easy to program for, and an FPU has become standard equipment on most high-performance PC compatibles.

Intel's original 8087 FPU can run at speeds of up to 10 MHz. The 80287 FPU, which is designed to work with the 80286, can run at the same speeds and uses the same instructions, but it was also designed to work with the 80286's protected mode. The 80387 and 80387SX, designed to work with the 80386 and 80386SX CPUs, can run at higher clock speeds, but they also include additional instructions. And there is no 487—the i486's FPU is built into the same chip as the CPU.

Intel has never been the only source for numeric coprocessors that work with its CPUs. For years, Weitek has sold a very fast FPU that's designed to work with 80x86 CPUs. However, the Weitek Abacus coprocessor isn't compatible with the 80x87 FPUs and requires special programming. The Abacus is also significantly more expensive than an 80x87.

In the last year, Intel has lost its monopoly on 80x87-compatible chips. Integrated Information Technology has introduced the IIT 2C87, a CMOS coprocessor that can plug into the same socket as an Intel 80287 and performs the same instructions faster than the Intel chip at the same clock speed. The IIT chip also runs at up to 20 MHz but costs about the same as the Intel chip. IIT plans to begin selling an 80387-compatible chip this year. And Advanced Micro Devices is planning a line of FPUs to go along with its new high-speed 80286 CPUs.

But because clone makers can buy CPUs from companies other than Intel, some strange infighting continues to stir up the PC-compatible waters.

For example, a month before last fall's Comdex show in Las Vegas, a series of billboards and newspaper and magazine ads began to appear throughout the U.S. In the two-page print version, the left page showed a large black "286," crossed out with a spray-painted red "X"; the right page had an equally large black "386," with a spray-painted red "SX" scrawled next to it. Intel's message was clear: Forget about an 80286-based PC and buy an 80386SX-based computer instead.

Why would Intel attack the 80286, its own chip? Although Intel originated the 80286, the chip's other sources, AMD and Harris, have worked hard to strip away many of Intel's customers by offering improved versions. The Intel incarnation is slow and power-hungry—the fastest version runs at only 12 MHz and requires up to 600 milliamps of power, which makes it an unsatisfactory choice for laptops, for example. By contrast, the Harris version can run twice as fast and still draws much less power because it's manufactured using a fully static CMOS design.

Thus, Intel has taken out ads to encourage customers to buy computers based on its 80386SX CPU, which can run 80386 software. (In the early 1980s, Intel went that same route when it told some of its customers that NEC's V20 and V30 CPUs infringed on Intel's copyrights. That ploy eventually led to a lawsuit by NEC; in the end, the judge ruled that NEC hadn't infringed on Intel's rights.) This recent ad campaign, which actually began almost two years ago, has worked—sort of. More 80386SX-based PCs are being sold, but mostly at the expense of full-scale 80386-based machines rather than those based on the 80286.

Coming Attractions

The 80286 isn't the only chip over which Intel is fighting with its rivals. AMD was originally licensed to make 80386s; when Intel withdrew the license, the dispute went to an arbitrator, who is expected to render a decision within the next few months. In the meantime, an AMD executive recently said that "if the arbitration fails to deliver the 386 to us, we will reverse-engineer it." He also is reported to have added that if Intel won't license AMD to produce the i486 chip, AMD will create its own version of this chip, too.

Intel has had its own problems getting the first version of the i486 into machines you can buy. Originally, it hoped i486-based computers would be available by last fall, but engineers at Compaq spotted several bugs in the i486's built-in FPU. One bug cropped up in certain trigonometric functions; another appeared in a divide-by-zero error.

Intel corrected the bugs and began producing corrected versions of the i486 at the end of last November. But the retooling process has delayed the introduction of i486-based computers, including some relatively inexpensive versions (under $5000) from ALR and other clone makers.

Will low-priced 486 computers wipe out 25- and 33-MHz 80386-based PCs? Probably not. Nor is it likely that 80386SX-based PCs will destroy the market for 16- and 20-MHz 80286 machines (although the SX already seems to have done in the lower-speed 80386s). Nor will any of these chips eliminate the venerable 8088 and its work-alikes. Each of these chips is eminently well suited to its particular niche.

The 8088 and its cousins are slow but inexpensive, and they require very low power—a fact that makes them popular for lightweight portable computers and perfect for "palmtop" machines such as the Poqet PC and the Atari Portfolio.

The most popular class of personal computer today is the desktop computer based on the 12-MHz 80286. And the 80286 remains the chip of choice for single-user, single-tasking applications—especially versions of the chip that can run at up to 25 MHz.

The 80386 and i486 offer full-scale multitasking, and both chips carry Intel's promise that things won't change much in the next decade, at least as far as instruction sets go. That means that, like their younger brethren, these two "classics" should be around for quite some time to come. ■

Frank Hayes is a former BYTE news editor. He can be reached on BIX c/o "editors."

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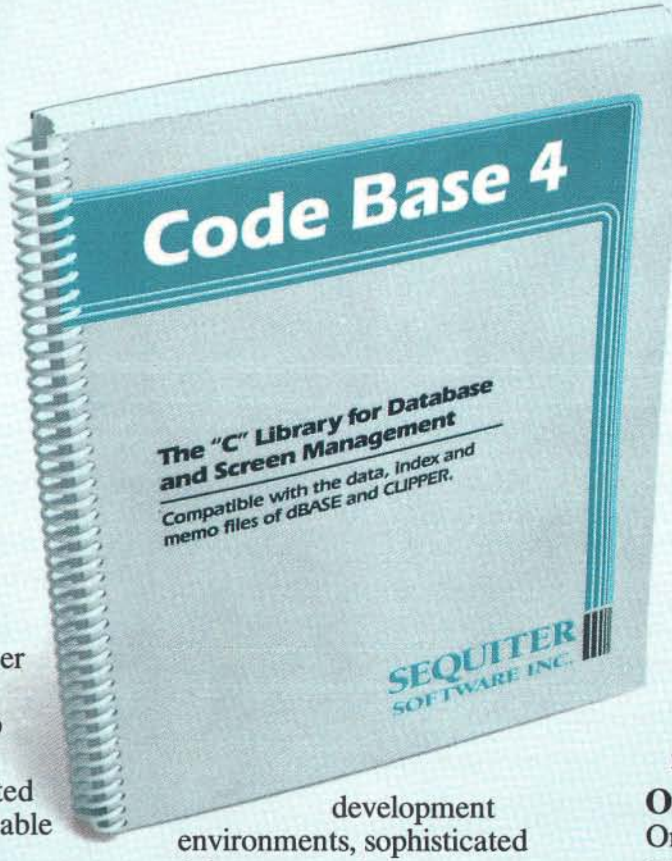
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THE BYTE UNIX BENCHMARKS

Separating fact from fiction in the exploding Unix empire

Ben Smith

Buying a new computer system calls for the same strategy you'd use when buying a new car. First, you start out with a list of features that you need. Then you look at performance. Finally, you decide how much you can afford to pay for a new system.

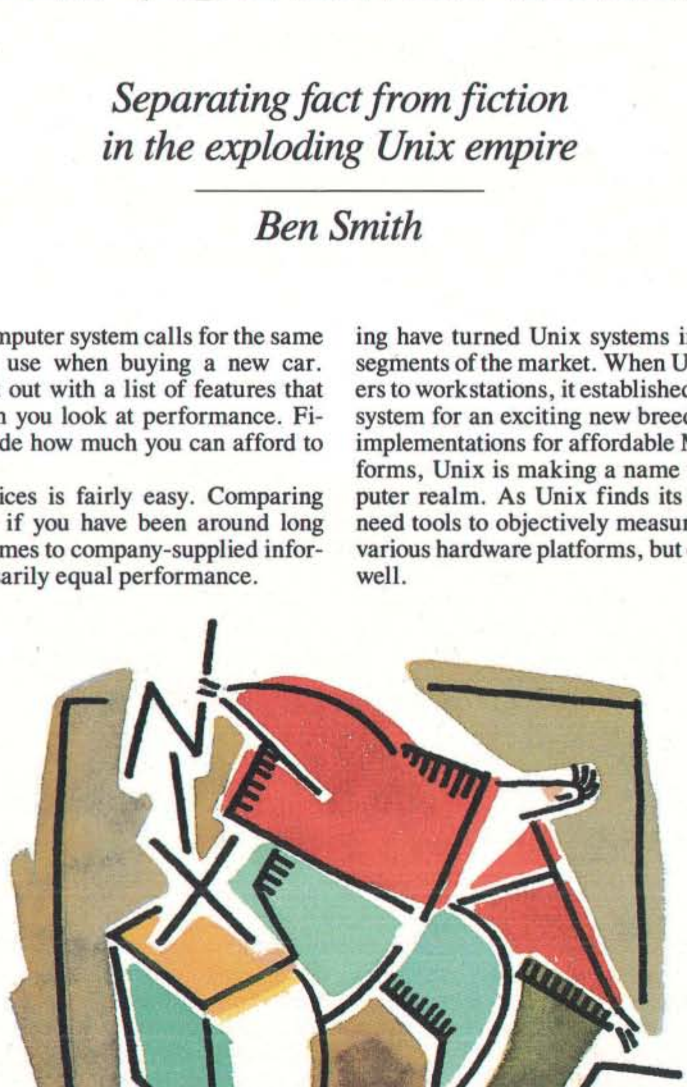
Comparing features and prices is fairly easy. Comparing performance isn't, especially if you have been around long enough to know that when it comes to company-supplied information, promises do not necessarily equal performance.

That's why, over the years, BYTE has emphasized the importance of objective, reliable benchmark tests in comparing computer performance. (See the text box "A Brief History of the BYTE Benchmarks" on page 274.) We have clocked innumerable systems using our benchmarks, and each review of a new system includes the results of these benchmarks.

With this issue, we mark a new milestone in our 15-year commitment to dependable benchmarks: the unveiling of the BYTE Unix benchmarks.

Unix Is Not MS-DOS

Although the largest number of microcomputers use MS-DOS or the Mac OS, these are no longer the only games in town. User demands for greater expandability, better performance, and multitasking have turned Unix systems into one of the fastest-growing segments of the market. When Unix stepped from minicomputers to workstations, it established itself as the de facto operating system for an exciting new breed of machine. Now, with solid implementations for affordable Motorola- and Intel-based platforms, Unix is making a name for itself in the personal computer realm. As Unix finds its way into the mainstream, we need tools to objectively measure the performance not only of various hardware platforms, but of different versions of Unix as well.



Conceptually, the BYTE Unix benchmarks are the same as BYTE's MS-DOS benchmarks: We have combined evaluation of low-level operations and high-level application programs to highlight the performance of the entire system.

However, Unix is considerably different from MS-DOS. In the first place, it is multitasking and multiuser, while MS-DOS is a single-tasking, single-user operating system. Unix is also portable, able to run on many different kinds of computers, whereas MS-DOS is intended to run on essentially one kind of machine, an IBM PC or compatible computer, using a specific class of processor from Intel.

As a result, BYTE's Unix benchmarks differ from their

continued

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A Brief History of the BYTE Benchmarks

Janet J. Barron

BYTE's commitment to objective benchmarks is as old as the magazine itself. In our third issue (November 1975), editor Carl Helmers authored two articles in which he explained the derivation of the term *benchmark* (systems engineers adopted it from the field of geodetic surveying) and set out the guidelines for what constituted a capable, under-$1000 personal computer.

At that time, the field of microcomputers was in a state of flux, and no standards existed for CPUs, buses, or peripherals. Thus, that first benchmark proposal focused on features rather than performance. To test the myriad nascent systems, BYTE readers were encouraged to develop their own criteria. Many did so, and some contributed the results of their efforts to BYTE. Among those articles was Jim Gilbreath's "A High-Level Language Benchmark" (September 1981), which introduced the now-classic Sieve of Eratosthenes benchmark for comparing a variety of language compilers (e.g., FORTRAN, BASIC, Pascal, and C) and machines that ran those compilers.

BYTE's first systematic use of performance benchmarks came in Gregg Williams's "A Closer Look at the IBM Personal Computer" in our January 1982 issue. Gregg described a series of simple BASIC benchmarks for the PC. BYTE later adapted those benchmarks to compare machines as disparate as a group of Japanese systems (May 1982 BYTE), and the Apple II and III with the IBM PC (September 1982 BYTE). The rationale for using BASIC benchmarks was availability; in spite of the vast differences in computers at that time, most had some kind of BASIC interpreter. As more computers and peripherals became available, benchmarks increased in importance, to the point where BYTE devoted an entire theme to them in the February 1984 issue.

The June 1984 issue carried a new look for the entire magazine and began to feature a dedicated page of benchmark results for each system reviewed. The new benchmark suite included BASIC tests (hard disk read and write, the Sieve, and calculation), operating-system tests (disk copy and file copy), and application tests (spreadsheet load and recalculate). These became the standard for BYTE system reviews.

C-ing the Future

The advent of increasingly powerful microcomputers compelled us to generate a new series of benchmarks that could be used across a broad array of systems. To that end, BYTE rolled out its new benchmarks in the June 1988 issue. The new benchmarks were written in Small-C, a public domain language with versions available for both the Intel (80x86) and Motorola (680x0) family of CPUs. The benchmarks were designed by BYTE's computer laboratory personnel to rank the performance of machines without regard to the operating system. The tests included low-level benchmarks of CPU, FPU, disk, and graphics capabilities, and application benchmarks designed to give users a better idea of how machines perform using specific products.

Proof of the pudding that machines have gotten speedier by orders of magnitude is the fact that BYTE already is beefing up its latest suite of benchmarks. At the time when they were created, the current benchmarks looked at 10- to 12-MHz machines. The arrival of 80386 machines with speeds of up to 33 MHz has created a need for more robust benchmarks. Now under way are benchmarks that will reflect how systems operate in a multitasking environment. Our next generation of benchmarks will be easier to maintain and port and will be able to be adjusted on the fly. They will use C hooked into assembly language to provide more iterations than the ones presently in use.

The code for the BYTE benchmarks has always been freely available; there are no secrets about what's being tested and how it's done. While this approach has left the tests open to occasional criticism, it has also made them reliable and objective. Keeping you up to date on how best to compare and measure the performance of systems and software is a priority at BYTE.

Janet J. Barron is a BYTE technical editor. She can be reached on BIX as "neural."

MS-DOS counterparts. Even though there are some equivalent low-level tests, you will find that even these run differently. The popular Dhrystone benchmark commonly gives different results, on the same hardware, when run under DOS and Unix. The reason for this is that different compilers are being used, and the underlying operating systems and services are wildly different.

Another important difference is that Microsoft is the only real source of DOS; other suppliers simply repackage Microsoft's basic operating system under other names. In contrast, there are many different kinds of Unix, and while similarities exist (the core Unix from Dell, Everex, and Interactive Systems is virtually the same), there are Unix and Unix-like operating systems that differ greatly from one another. Thus, the Unix benchmarks are evaluating the implementation of Unix and the resident compiler as well as the hardware on which they are running (the MS-DOS and Apple Macintosh benchmarks use a common compiler, the public domain Small-C).

With so many variables, what is constant? Well, we have established a baseline: SCO Xenix 386 version 2.3.1. running on the Everex Step 386/33 with 4 megabytes of RAM and an 80387 math coprocessor. While it isn't Unix per se (because AT&T decides which implementations can be called "Unix"), it is more popular than any other personal computer Unix implementation. It is specifically designed for 80386-based computers with full 32-bit memory access.

The Everex 386/33 was chosen because it is one of today's highest-performance 80386 computers properly configured to run the full 32-bit operating system. (Some 80386 computers cannot access memory through single 32-bit operations—small matter if you are just running MS-DOS, an 8-bit operating system, but serious if you want to run Unix.) This combination of hardware and operating system is timely, but we'll continue to adjust the baseline as needed to reflect the installed personal computer and workstation Unix base.

The Low-Level Benchmark Programs

The BYTE Unix benchmarks consist of eight groups of programs: arithmetic, system calls, memory operations, disk operations, Dhrystone, database operations, system loading, and miscellaneous. These can be divided into low-level tests (i.e., arithmetic, system calls, memory, disk, and Dhrystone) and high-level tests (i.e., database operations, system loading, and the C-compiler test that is part of the miscellaneous set).

The Dhrystone test is known more formally as Dhrystone 2 (listed in the table as dhry2). It performs no floating-point operations, but it does involve arrays, character strings, indirect addressing, and most of the non-floating-point instructions that might be found in an application program. It also includes conditional operations and other common program flow controls. The output of the test is the number of Dhrystone loops per second. We also included a version of the Dhrystone test with registers (dhry2reg).

A future version of the BYTE Unix benchmarks will also include the Whetstone benchmark program. The Whetstone benchmark is conceptually similar to the Dhrystone, but it emphasizes math; it is a mix of floating-point and integer arithmetic, function calls, array operations, conditionals, and transcendental function calls.

All the arithmetic tests have the same source code with different data types substituted for the operations: register, short, int, long, float, double, and an empty loop for calculating the overhead required by the program (arithoh). The actual test involves assignment, addition, subtraction, multiplication, and division. Very simple. But don't bother running the float and double-precision test unless you have a math coprocessor; what takes a math coprocessor system 15 seconds can take an unaided processor 30 minutes or more.

MS-DOS and the Mac OS are no longer the only games in town.

The system call tests are system call overhead (sysoh), pipe throughput (pipe), pipe context switching (context), spawning of child processes (create), replacement of the current process by a new process (execl), and file read, write, and copy (which were not completed in time to be included in the table but will ship with the benchmark code). The system call overhead test evaluates the time that's required to do iterations of `dup()`, `close()`, `getpid()`, `getuid()`, and `umask()` calls.

The pipe throughput test has no real counterpart in real-world programming; in it, a single process opens a *pipe* (an interprocess communications channel that works rather like its plumbing namesake) to itself and spins a megabyte around this short loop. You might call this the "pipe overhead" test. The context-switching pipe test is more like a real-world application; the test program spawns a child process with which it

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carries on a bidirectional pipe conversation.

The spawn test creates a child process that immediately dies after its own `fork()`. The process is repeated over and over. Similarly, the execl test is a process that repeatedly changes to a new incarnation. One of the arguments passed to the new incarnation is the number of remaining iterations (there has to be some control, after all).

The file read, write, and copy tests capture the number of characters that can be read, written, and copied in a specified time (default is 10 seconds). If you run this test with the minimum element (1 second), you should see a significantly higher value for all operations if your system uses disk caching. Be sure you have plenty of disk space before you run this test.

The High-Level Benchmark Programs

To qualify as a high-level test, the test must involve operations that a real-world application program might employ, including heavy use of the CPU and disk. At the time of this writing, we have implemented only the system loading and database tests, but we will be adding several new tests in the months ahead.

The system loading test is a shell script that is run by one, two, four, and eight concurrent processes (shell1, shell2, shell4, and shell8). The script consists of an alphabetic sort of one file to another; taking the octal dump of the result and doing a numeric sort to a third file; running `grep` on the result of the alphabetic sort file; `tee`ing the result to a file and to `wc` (word count); writing the final result to a file; and removing all the resulting files. This script was used in the original BYTE Unix benchmarks (1983), but the source file is several magnitudes larger than the original.

The C compile and link (cc) is nothing more than that.

The database operations consist of random read, write, and add operations on a database file. The operations are handled by a server process; the requests come from client processes. The test is run with one, two, four, and eight client processes. The test uses semaphores and message queues. Semaphores are being used less and less these days. BSD systems use sockets in place of both of these System V.3 IPC utilities. System V.4 offers both. (Since the database test can't run uniformly on all flavors of Unix, we won't be publishing results of the test; however, the code will be included on the benchmark disk.)

This test is being rewritten using sockets, but since Xenix doesn't implement sockets, our baseline configuration becomes instantly obsolete when we replace the database test. Just another one of those little problems in trying to create journalistic computer benchmarks: Any program that has been fully debugged is probably obsolete [Murphy, et al].

The remaining tests are in the miscellaneous group: Tower of Hanoi (tower) (a test of recursive operations) and a test of the Unix arbitrary precision calculator calculating the square root of 2 to 99 decimal places (dc).

We will no doubt add tests to this suite as we see the need to test and evaluate from different perspectives.

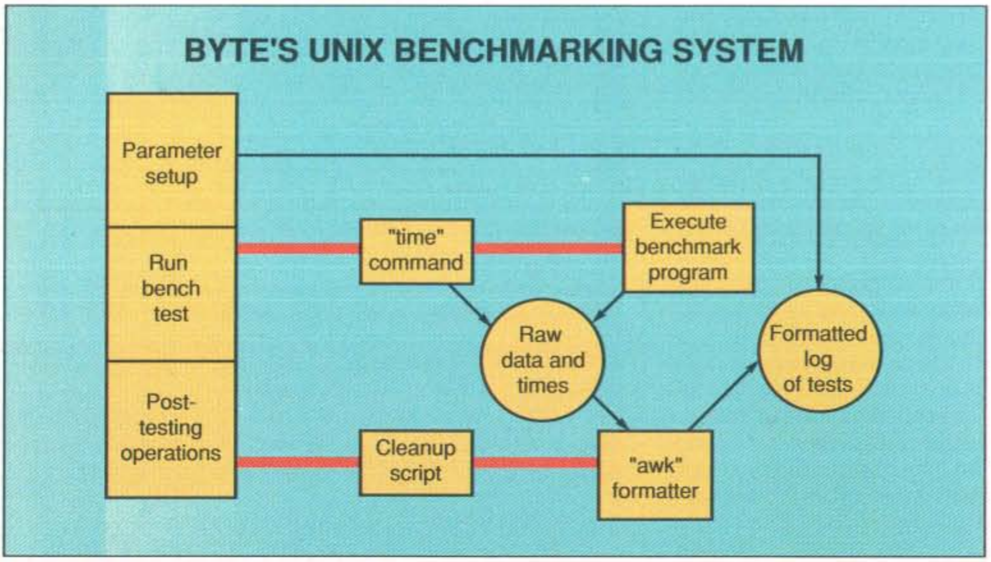
Problems in the Modern World

The major problem we have had with developing the Unix benchmark programs is designing them so that they fairly reflect the strengths and weaknesses of all the systems on which we anticipate using them. For example, the operations should allow RISC machines to give appropriately high performance for the sorts of operations that RISC is good for, and they should also illustrate improvements provided by faster bus speeds, better math coprocessors, and the like. In the case of RISC, the efficiency of the compiler is of utmost importance; RISC compilers must rearrange instructions to take advantage of instruction pipelining (for an overview of RISC, see the May 1988 BYTE).

The majority of the Unix systems that we look at employ disk caching. This is especially important because modern Unix includes swapping and paging out to disk when there is insufficient memory for a task or the number of tasks. It is an interesting exercise to run the disk file operations test with increasingly large files and note the point at which performance drops.

How They Work

A 400-line Bourne shell script (`Run`) administers the benchmarking system. After the evaluation of the command-line options, the benchmarking operation for each test has three stages: parameter setup, timing the execution of the test, and calculation/formatting operations (see the figure). After `Run` determines the parameters for the test, it sends a formatted description to the output file and then invokes the specific test by means of the Unix command `time`. The output of `time` and any output from the test itself end up in a raw data file. Most tests are run six times so that any variance can be averaged. On completion of a set of tests, `Run` invokes a cleanup script, which does



The flow of BYTE's Unix benchmarking procedure. For each test, the `Run` *script controls the parameter setup, invoking the test (through* `time`*) and determining which post-test operations are needed. The* `awk` *formatting program does calculations and formatting of results.*

UNIX MACHINES TESTED

Each row represents an individual test, and the columns under the names of the systems indicate the result. (The Dhrystone tests are measured in number of loops; the other tests are measured in seconds.) The index columns show each system's performance relative to the baseline system (33-MHz Everex). The baseline results are in the first column, and the index for each test would be 1.00. Thus, an index higher than 1.00 on an individual test indicates that that system did better than the baseline. The bottom row, titled "Cum. index," is the sum of the indexes of six tests (indicated below by an asterisk). Again, the higher the number, the better the performance.

	Everex	**NeXT**	**Index**	**DEC3100**	**Index**	**HP370**	**Index**
dhry2*	**13847**	5921	0.42	23077	1.66	16073	1.16
dhry2reg	**14634**	5932	0.40	23077	1.57	16003	1.09
arithoh	**0.72**	0.53	1.35	0.22	3.27	0.21	3.42
register	**2.92**	6.83	0.42	3.52	0.82	4.92	0.59
short	**3.52**	6.13	0.57	3.52	1.00	4.92	0.71
int	**3.12**	6.82	0.45	3.52	0.88	4.90	0.63
long	**3.12**	6.82	0.45	3.52	0.88	4.90	0.63
float*	**11.92**	13.02	0.91	2.43	4.90	11.27	1.05
double	**13.22**	15.63	0.84	2.02	6.54	10.85	1.21
sysoh	**1.10**	2.03	0.54	0.63	1.74	0.90	1.22
pipe	**0.92**	2.72	0.33	0.93	0.98	1.70	0.54
context	**0.63**	0.93	0.67	0.40	1.57	1.22	0.51
create	**1.23**	2.22	0.55	0.52	2.36	0.98	1.25
execl	**3.43**	3.03	1.13	1.27	2.70	2.12	1.61
shell1	**4.06**	8.33	0.48	4.30	0.94	6.40	0.63
shell2	**5.80**	11.57	0.50	4.47	1.29	8.52	0.68
shell4	**9.60**	18.93	0.50	7.33	1.30	14.57	0.65
shell8*	**17.30**	33.60	0.51	13.00	1.33	26.58	0.65
cc*	**2.08**	5.68	0.36	3.61	0.57	5.03	0.41
dc*	**0.63**	0.65	0.96	0.48	1.31	0.53	1.18
tower*	**0.56**	1.63	0.34	0.42	1.33	0.62	0.90
Cum. index	**6.00**		3.54		11.12		5.37

the statistical calculations on the raw data using the awk formatting language.

The greater part of the benchmark programs are written in C and are compiled on the test machine prior to running the tests.

Using the Results

If all you need is a raw measure of performance, then feel free to use the Dhrystone and Whetstone tests as indexes of just that. But if you want to use the benchmarks to evaluate a machine's ability to serve some real need, you should follow these:

1. Analyze your requirements regarding the type of computing, amount and type of communications I/O, and amount and type of disk I/O.
2. Score the subject machines using weighting factors that reflect your requirements.
3. Generate a price versus performance plot.
4. Use the price versus performance results along with information about the reliability and serviceability of the hardware.

Step 4 is more of an art than anything else, but it is very important that you do not rely solely on price versus performance.

We use our Unix benchmarks for doing a rough analysis and comparison of divergent machines (see the table). We even go so far as to generate a single index number, a sort of reduction of all the benchmark tests to a single value. This index is generated by summing the individual indexes of the Dhrystone 2 test, the floating-point test, the shell test with eight concurrent processes, the C compiler time, the DC arithmetic routine, and the Tower of Hanoi time. By definition, the combined index for the baseline machine is 6.0. Indexes above 6.0 imply a better overall performance than the baseline machine; indexes less than 6.0 imply worse performance.

Keep in mind that having a single index rating for a machine can make good dinner conversation, but it is incredibly simplistic. It is like reducing a complex sculptural shape to a single point; you no longer can tell what you are looking at. This number doesn't reflect any real-world use of a Unix system. But the index is devised so that it gives an overall indication of different kinds of system operations and so is valuable to our reviews.

BYTE's Unix benchmarking suite is small enough to port easily to any Unix system, yet diverse and flexible enough to be useful for a wide spectrum of benchmarking requirements. Besides, they're in the public domain, so they can be obtained for little, if any, cost. What better reason do you need to use them? ■

Editor's note: *The BYTE Unix benchmarks, BENCH_1.SHR, BENCH_2.SHR, and BENCH_3.SHR, are available in a variety of formats. See page 5 for details.*

Ben Smith is a technical editor for BYTE. He can be reached on BIX as "bensmith."

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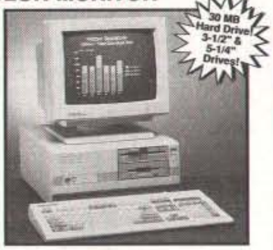

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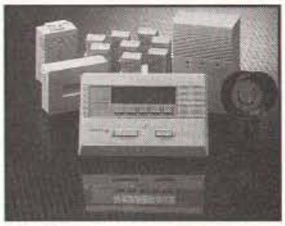

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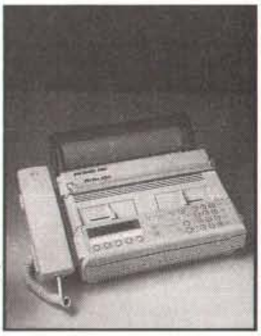

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DRAWING ON THE 8514/A

There is more to the 8514/A graphics processor than the IBM Adapter Interface would let you believe

Ben Cahill

In 1987, IBM introduced its first PC graphics board that offered real hardware coprocessing/acceleration—the 8514/A. It went way beyond the VGA and its other predecessors in its ability to offload repetitive and mundane pixel-by-pixel drawing tasks from the CPU. And yet IBM's product didn't come close to taking full advantage of its own capability. The Adapter Interface software, which IBM bundled with the 8514/A board, isolated the user from the actual hardware. Now, independent companies have cloned the board with just a few chips and opened up the 8514/A design. This article will concentrate on demystifying the drawing procedures that really give the 8514/A its coprocessing impact.

Overhead in the Universal Interface

The Adapter Interface software presents a universal interface to applications software, and it is the only interface sanctioned publicly by IBM (which has never published a hardware register specification). In theory, the IBM Adapter Interface is a nice idea, and it is a useful approach for many applications. In practice, however, this approach carries a great deal of overhead, slowing the hardware graphics performance to a crawl relative to what the hardware is actually capable of doing.

A few important chip manufacturers have introduced 8514/A-compatible ICs and opened up the previously closed world of the 8514/A hardware architecture. The Adapter Interface hints at the functionality, but the actual capabilities of the hardware have remained a bit of a mystery until now.

Introducing the Architecture

In a nutshell, the 8514/A is responsible for drawing shapes and colors into a video RAM image memory, as well as controlling the rasterized display of this image to a video screen. To accomplish these tasks, the 8514/A consists of five major sections: the host interface, the drawing or "shape" engine, the color data path, the video controller, and the image memory controller (see figure 1).

Even though IBM has supported only the Micro Channel (PS/2) bus with its 8514/A, most of the compatible-chip vendors support both the Micro Channel and the Industry Standard Architecture (PC/XT/AT) buses, either 8- or 16-bit. Other bus standards can also be accommodated with little external circuitry. This affords a wide range of flexibility in choosing the target system.

The host interface provides the host computer with access to three 8514/A subsystem elements. These include a ROM (in memory space), as well as the RAM-accessing digital-to-analog converter (RAMDAC) and the 8514/A registers (in I/O space). The ROM holds setup code and can also be used for BIOS extensions if desired. The RAMDAC contains the color palette used when displaying the image on the screen. The 8514/A registers include drawing command and parameter registers, video display control registers, and other operational setup registers.

The host interface includes an input queue, which can stack up to eight I/O words (16 bytes) of drawing commands and data. This enhances performance by allowing the host to blast a string of commands into the 8514/A without having to wait for the previous command to finish. Software can monitor the queue fill level by polling or by interrupts.

Note that the 8514/A image memory is not mapped into host system memory space. The only way to read or write image memory is via the 8514/A drawing commands, which are set up and fed entirely through I/O ports. This is an important performance plus, because the host CPU never needs to perform time-consuming memory-address calculations. It simply shoves color data (when needed) into the same I/O port, byte after byte, and lets the 8514/A take care of the rest.

The shape engine and the color data path are the two major architectural blocks that make up the heart of the 8514/A drawing logic. This is where the real graphics coprocessing/acceleration happens. The shape engine is a sophisticated sequencer that controls the current (x,y) pixel marking position while

continued

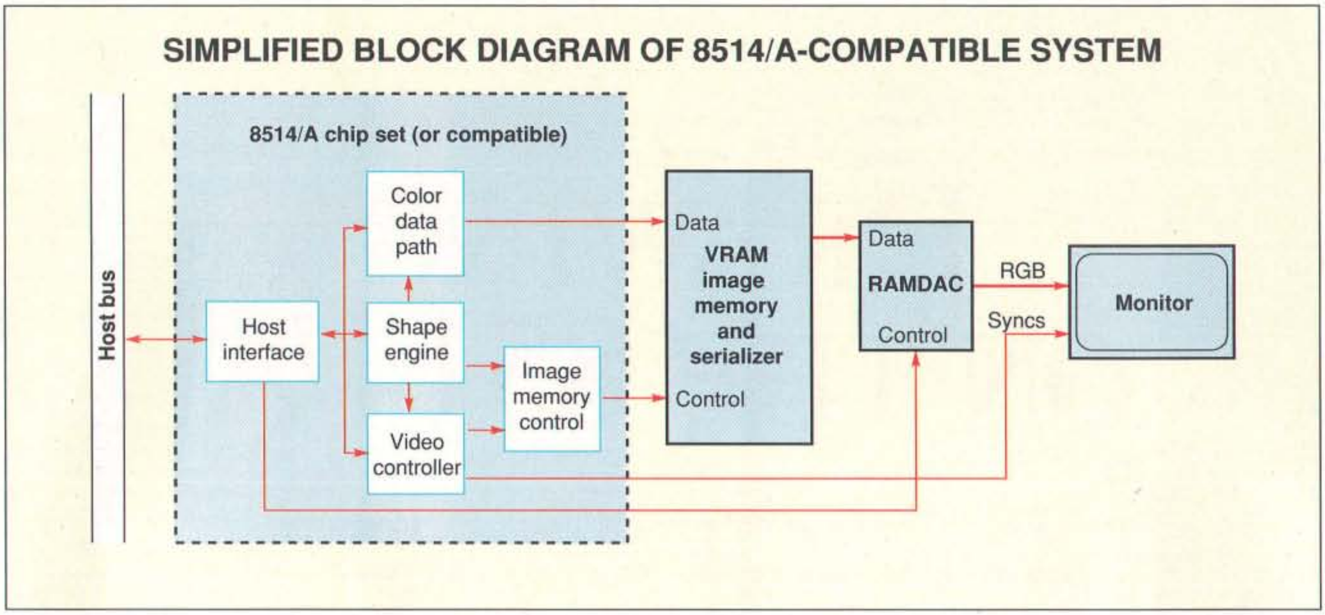

Figure 1: *The host CPU only needs to stream instructions to the host interface. The 8514/A takes care of all operations from there, including management of the video RAM and control of the RAM digital-to-analog converter (RAMDAC).*

drawing lines or rectangles. The color data path contains ALUs and data selection logic to determine the color index value with which the current pixel position is marked.

This structure is similar to many other true graphics systems. The relative independence of the shape and color functions is key to understanding the drawing algorithms, which I will explore shortly.

The video controller generates the video signals (vertical sync, horizontal sync, blank) and controls the video RAM serial output ports when displaying the image on the video screen. Video display parameters of the 8514/A are completely programmable, offering resolutions of up to 1024 by 1024 pixels, interlaced or noninterlaced. Most of the clone makers offer a superset of this range. Chips & Technologies, for example, offers resolutions of up to 2560 by 2048 pixels, with compatible programming techniques.

The host CPU never needs to perform time-consuming memory address calculations.

The image memory controller takes care of the low-level dirty work required for the video RAM memory. It accepts memory cycle requests from both the shape engine and the video controller and generates the appropriate address, row-address strobe, column-address strobe, write enable, and other signals to control both the parallel and the serial ports of the video RAMs.

These functions are largely transparent to the user, however. Understanding the structure of the image memory is fundamental to understanding the whys and wherefores of the drawing algorithms. The image memory consists of multiple bit planes (up to eight), which are pixel-mapped to the display screen. Each pixel you see on the display screen has a specific associated location in the image memory, which contains 8 bits of data. This 8-bit value, called the color index, allows for up to 256 different color values for each pixel.

This memory is a simple image buffer that behaves in a "what you draw is what you get" fashion. Unlike VGA and other predecessors, there are no special text modes or attributes that interpret memory contents (creating character images from character codes, causing characters to blink, and so forth) before they reach the display screen. Instead, image data is fed directly, with no changes, through a RAMDAC on its way to the screen. The RAMDAC contains a color palette that translates the 8-bit color index into analog RGB values to create the actual colors on the display screen.

The image memory is structured in a wide-word fashion. Each memory access can read or write 4 pixels simultaneously (there is also a special mode for accessing 5 pixels simultaneously). This aspect of the architecture is reflected in the 8514/A's ability to treat variable pixel data (from the host system) in two different formats: across-the-planes and through-the-planes.

In through-the-planes mode, each byte of variable data applies to 1 pixel. Each bit within that byte relates to a given color plane for that pixel (the byte pierces "through" all the planes). This mode is relatively slow, but it allows for transfers of 256-color images between the host system and the 8514/A subsystem in a single command pass.

In across-the-planes mode, however, each byte of variable data applies to 4 pixels. Each of 4 bits (bits 1–4) relates to a given pixel within a horizontally contiguous 4-pixel group: a *nugget*. (The 4 bits straddle 4 pixels.) The remaining 4 bits of the data byte are ignored. The function of the 4 active bits is to choose the mix for each of the 4 pixels (more on this later). across-the-planes mode can be up to four times faster than

continued

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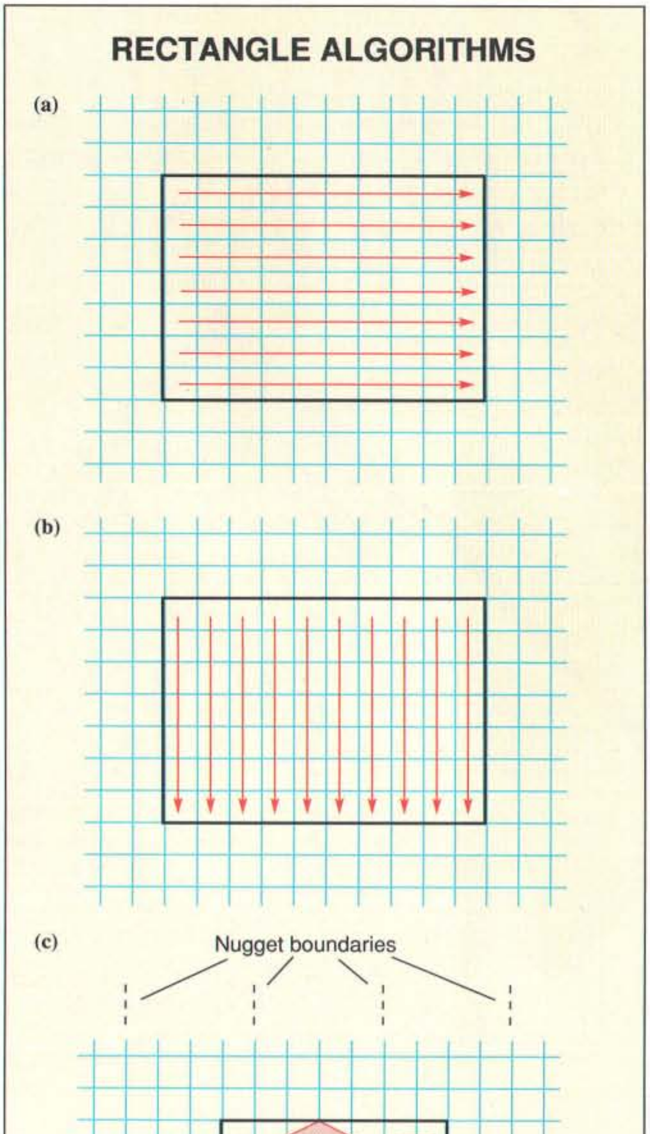

Figure 2: (a) *The X-Rectangle algorithm in across-the-planes mode is the fastest way to draw and fill a rectangle, because it moves 4 pixels at a time using the parallelism of the 8514/A.* **(b)** *The Y-Rectangle algorithm moves only 1 pixel at a time.* **(c)** *The Fast Y-Rectangle algorithm gains speed by using nugget-wide passes (provided that the area has good alignment with nugget boundaries) and alternately sweeping up and down each nugget-wide path.*

through-the-planes mode, but it allows only two colors/mixes for each command pass.

The Shapes

With an understanding of shape creation and pixel block transfer (BLT), you can explore the combinatorial logic of the color data path. Both shape creation and pixel BLT are repetitive, sequential operations performed in the shape engine.

The 8514/A has three shape algorithms for drawing rectangles, one for copying rectangles from one area of image memory to another, and three for drawing lines. Most of these algorithms are useful not only for writing data into the image memory, but also for reading data back from image memory into the host system.

Rectangle Algorithms

A set of four spatial parameter registers—Current-X, Current-Y, Rectangle-Width, and Rectangle-Height—and the single Command register control all three rectangle algorithms: the X-Rectangle, the Y-Rectangle, and the Fast Y-Rectangle. You program all the parameter registers in terms of pixels. The upper left corner of the display screen (0,0) is the reference for absolute pixel positions. The X position value increases to the right, while the Y value increases in the downward direction.

All three rectangle algorithms produce the same rectangular shape when the parameter registers and the Command register are set up identically. You initialize the Current-X register and Current-Y register to point to the starting corner of the rectangle. You also set the Rectangle-Width and Height registers to reflect the dimensions of the rectangle. You can set the orientation of the rectangle so that it fills any of four quadrants relative to the starting corner by setting the Increment-X and Increment-Y bits appropriately. You actually draw by writing these bits along with the Command code into the Command register.

The differences in the three rectangle algorithms lie in the way the current pixel position moves within the rectangle while drawing is in progress. These differences are important only when pixel data is transferred between the host system and the 8514/A. Otherwise, the X-Rectangle is the fastest algorithm (in across-the-planes mode) and the first choice for drawing solid filled rectangles and clearing the screen.

When you use X-Rectangle, the current pixel position moves horizontally (consistently left or right as determined by the Increment-X bit) as each line of pixels is drawn (see figure 2a). When handling through-the-planes data from the host system, it moves 1 pixel at a time. At each pixel, it makes sure that the host has sent a data byte. Since each data byte controls 4 pixels when handling across-the-planes data from the host system, it moves 4 pixels at a time (with potential exceptions at the left and right edges). Even when no host system data is used, it can move 4 pixels at a time.

The Y-Rectangle algorithm causes the current pixel position to move vertically, consistently up or down as determined by the Increment-Y bit (see figure 2b). This algorithm always moves 1 pixel at a time and thus is useful for handling through-the-planes pixel data from the host. The Fast Y-Rectangle moves in a strange way, sweeping alternately up and down in swaths up to 4 pixels wide (see figure 2c). It is used principally with across-the-planes data from the host, and it behaves the best when the rectangle encompasses only whole nuggets.

The X- and Y-Rectangles are particularly useful for drawing rasterized images, such as a 256-color picture of a house, in any of eight rotated/mirrored orientations. Figure 3 shows the character "P" drawn eight ways. In each case, the rasterized data

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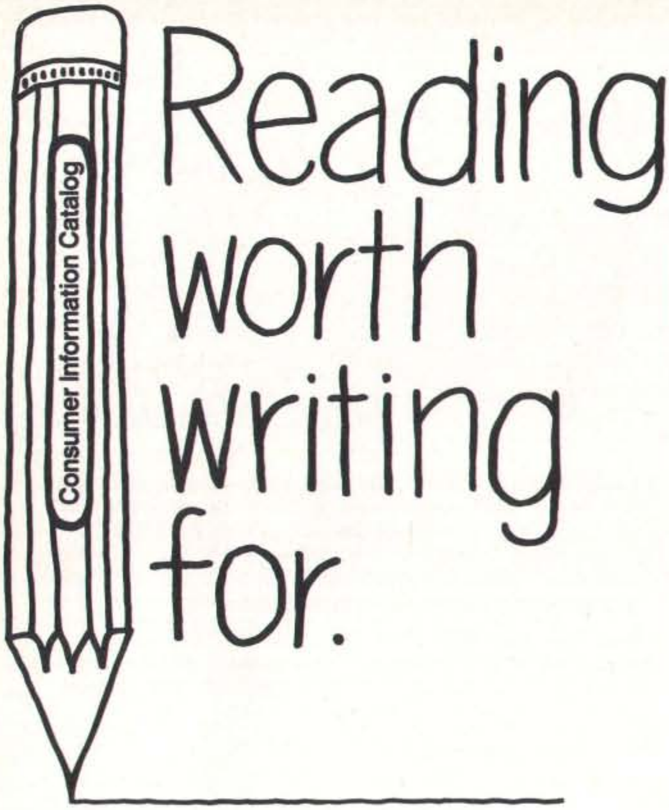

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was fed from the host system to the 8514/A 1 pixel at a time, and in the same order, to the same 8514/A variable data I/O port. The 8514/A took over the burden of calculating the proper image memory addresses for each different orientation.

Copy Rectangle Algorithms

The Copy Rectangle command is used principally for pixel BLT of rectangles within the image memory. This is a very powerful function, since very large image areas can be manipulated by sophisticated color selection functions without any intervention from the host system.

There are two rectangles of interest here, the Source Rectangle and the Destination Rectangle. Both rectangles are the same size. For each pixel read in the Source Rectangle, the 8514/A writes a pixel into the Destination Rectangle at the corresponding position. You enter the Source Rectangle starting corner into the Current-X and Current-Y registers, and the Destination Rectangle starting corner into the Destination-X and Destination-Y registers. You enter the dimensions of the rectangles into the Rectangle-Width and Rectangle-Height registers. As always, writing the Command code to the Command register starts the drawing operation.

Line Algorithms

Three line-drawing algorithms—the Solid Bresenham Line, the Bresenham Outline, and the Short-Stroke Vector—round out the shape engine's arsenal. The Solid Line is a general-use algorithm for drawing lines of any length at any angle. The Outline is a special-purpose mutation of the Solid Line, used for drawing boundaries of irregular areas to be color-filled (more on this later). The Short-Stroke Vector is used for drawing a series of short lines and provides a compact data format for describing those lines. It is used for drawing characters and icons.

The Solid Bresenham Line and Bresenham Outline can be programmed to draw in any one of eight multiples of 45 degrees, or they can be programmed to use the Bresenham algorithm for any slope whatsoever (see figure 4a). Both approaches use the Rectangle-Width register to program the length of the line, and 3 bits in the Command register to specify the octant in which the line is drawn. In addition, the Bresenham algorithm requires the programming of two step constants and an initial error term, all of which are based on the slope of the line.

The Bresenham Outline marks pixels only when moving from one horizontal pixel row to another. That is, it marks only 1 pixel in each scan line, skipping some pixels in lines with slopes less than 45 degrees from the horizontal (see figure 4b). This is used to draw the boundary outline for a random area fill. In a subsequent pass with an X-Rectangle or Copy Rectangle command, logic in the color data path will detect these single pixels and will cause fill marking to alternately turn on or off at each detected pixel.

The Short-Stroke Vector draws only in increments of 45 degrees. Each vector starts where the previous vector ended (see figure 4c). A single byte from the host system describes each vector. Four bits in each byte describe the length of the vector (up to 15 pixels). Three bits specify the direction (eight possibilities, each a multiple of 45 degrees). The last bit tells whether the vector is visible or invisible. Invisible vectors can be used to connect two or more separate visible areas in a character, such as in a semicolon or an *i*.

The Colors

Now for the fun part. Much of the coprocessing power of the 8514/A lies in the color data path architecture. As the shape

continued

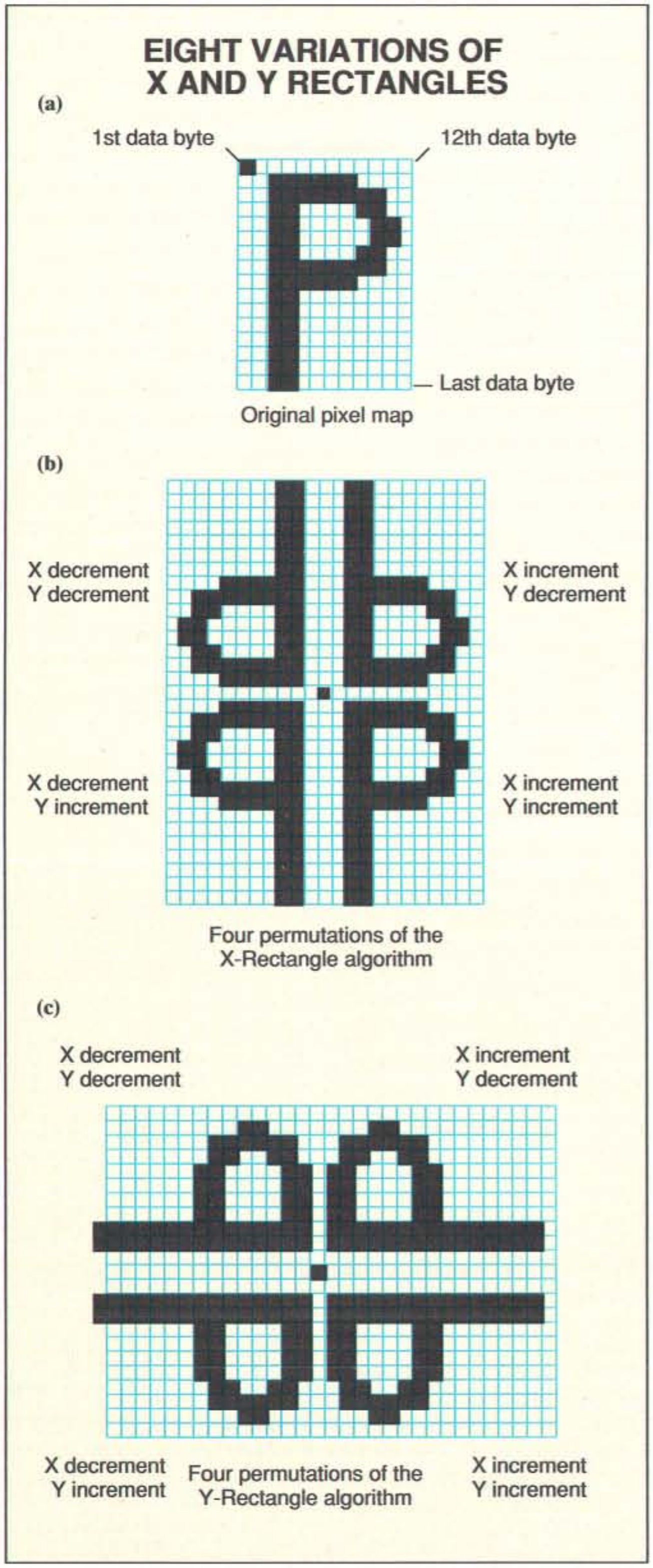

Figure 3: *By changing the setting of the command bits, the same data stream can be displayed eight different ways.* **(a)** *The original data stream with X-Increment and Y-Increment set.* **(b)** *and* **(c)** *The possibilities with different command-bit settings.*

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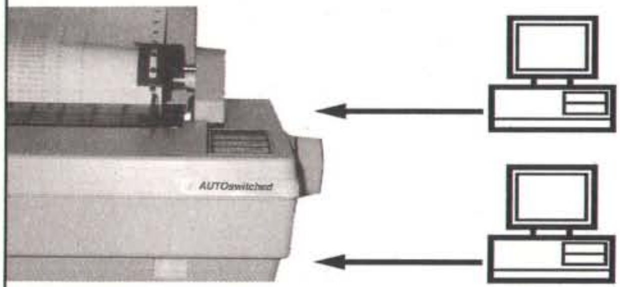

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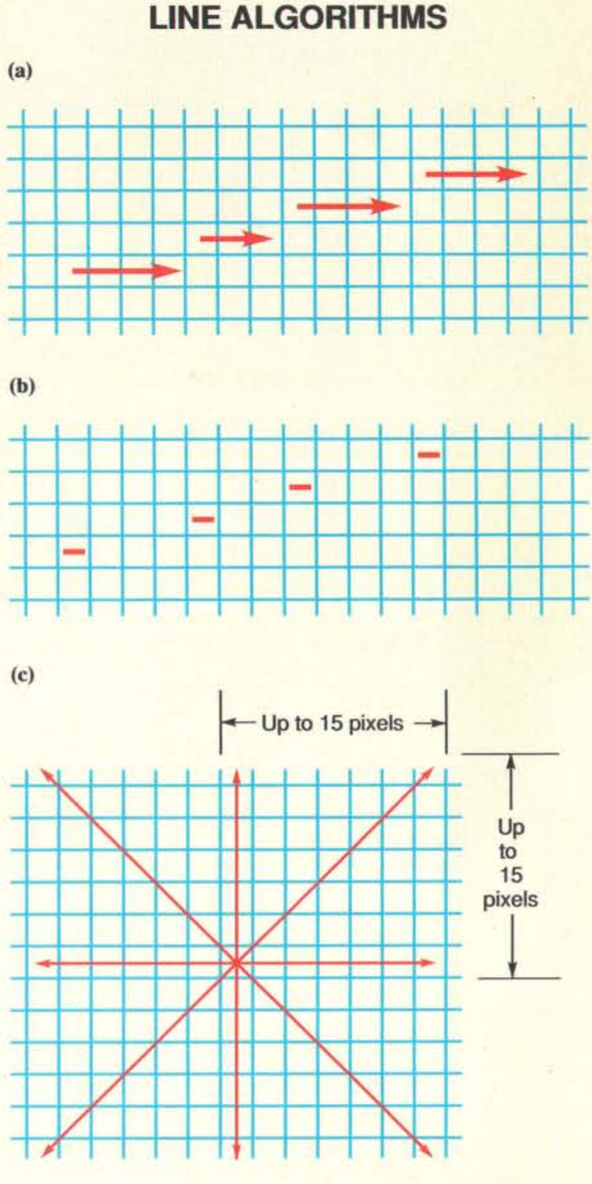

Figure 4: (a) *Solid Bresenham Line;* **(b)** *Bresenham Outline;* **(c)** *Short-Stroke Vectors.*

engine moves the current pixel position to create the lines and rectangles, the color data path makes it possible to execute some rather sophisticated color selection operations in a single pass—operations that other architectures require two or more passes to complete.

The heart of the color data path is, of course, the ALUs (see figure 5). There are four of them (five with the special mode I mentioned earlier). A powerful aspect of this architecture is its parallelism. If you've been wondering "Why nuggets?" here's your answer. Each ALU processes the data for one pixel position within a nugget. Up to 4 pixels can therefore be processed simultaneously, which is what across-the-planes mode is all about. In through-the-planes mode, only one ALU can be used

continued

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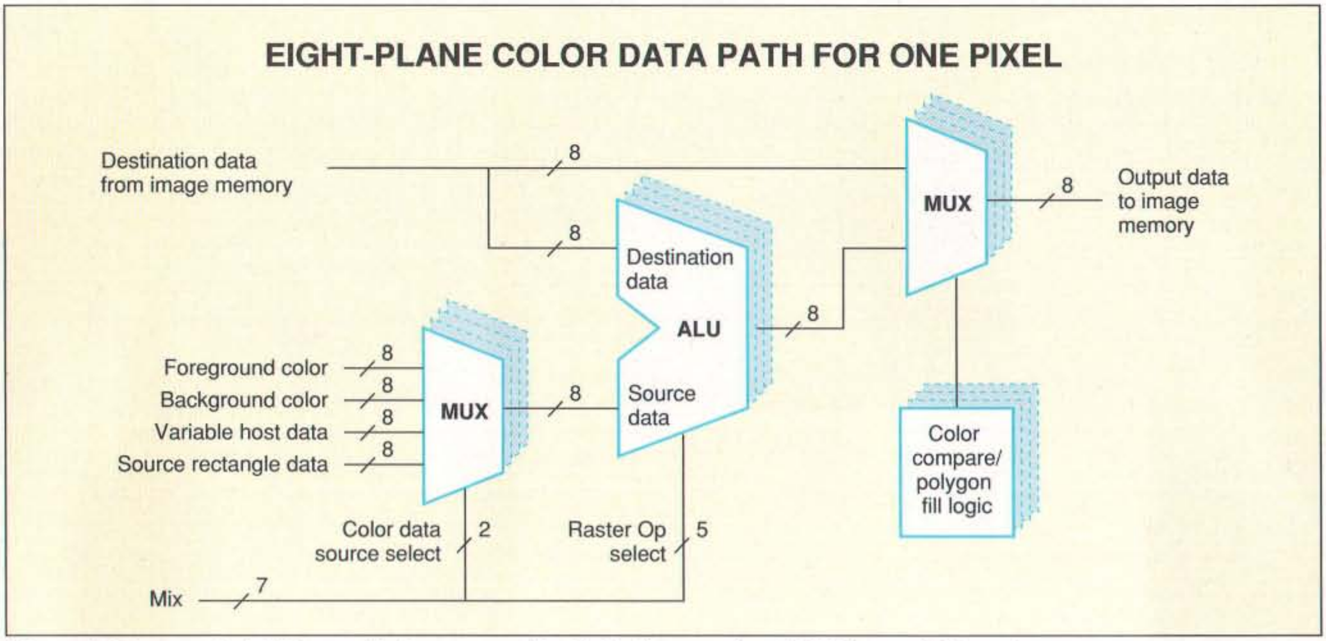

Figure 5: *Four parallel ALUs provide for nugget-wide (4-pixel) processing. (MUX is a multiplexer.)*

at a time, as each byte of variable data applies to only 1 pixel.

The functionality of the ALUs is quite comprehensive, including all possible logical operations (i.e., ANDs, ORs, XORs, forced 1s and 0s, pass-through, and inversion) and the basic arithmetic functions (i.e., additions and subtractions with or without saturation, averaging, and minimum and maximum functions). The particular ALU function is referred to as the "Raster Op."

Each ALU has two input data ports, one with a selectable source, *source* data, and one with a nonselectable source, *destination* data. The source data can be from any one of four sources: two 8-bit color registers (the Foreground Color and the Background Color), variable pixel data from the host system, and pixel data from the Source Rectangle in a Copy Rectangle command. The destination data is always the contents of the current nugget in image memory (before the operation).

Mixes

The *mix* is a particular combination of source data selection and Raster Op for an ALU. You can select the mix in real time for each and every pixel. This is the single most powerful feature of 8514/A architecture. There are two mix registers in the 8514/A. They are called (rather arbitrarily) the Foreground Mix and the Background Mix (see figure 6). Both have full access to all Raster Ops and source data possibilities (including both Foreground and Background Color registers).

A binary value associated with each pixel determines whether it is a Foreground or Background Mix for the pixel. This is where the across-the-planes data format comes into play, with its 4 bits of control data specifying Foreground (1) or Background (0) Mix for each of the 4 pixels within a nugget.

As there are four choices for ALU source data, so are there four choices for mix selection data. These two types of data are easily confused. Try to keep in mind the following: The ALU source data is 8-bit/eight-plane/through-the-planes formatted color data to *go through* the ALUs; the mix selection data is 4-bit/no-plane/across-the-planes data that *controls* the ALUs.

The simplest of the control sources is the Fixed Foreground source. It simply supplies 1s in all pixel positions, thereby selecting the Foreground Mix for all pixels. This source is used for solid color filled shapes, rasterized image transfers between the host and the 8514/A, or simple image memory pixel BLTs using the Copy Rectangle command.

A more intriguing control source is the pair of Pixel Mix registers. The low-order Pixel Mix register controls the even nuggets—those that start on X positions 0, 8, 16, and so on. The high-order Pixel Mix register controls the odd nuggets, starting at X positions 4, 12, 20, and so forth. A single drawing command can use these registers to fill an entire shape with a horizontally repeating 8-pixel-wide pattern.

You can also use variable data pumped in from the host system as a mix selector. This method is useful for creating any sort of nonrepeating two-color or two-mix pattern within a shape.

The most sophisticated control source is the Source Rectangle data. (You can use it only with the Copy Rectangle command.) If all read-enabled planes are "1" for a given source pixel, then the destination pixel uses the Foreground Mix. You can use this technique for quickly generating full-color characters, cursors, or icons on-screen from compact single-plane patterns stored in off-screen image memory.

Color Comparator and Bounded Fill Logic

The 8514/A architecture really shows its stuff with its ability to make single-pass color decisions using its Color Comparator and Bounded Area Fill logic. This logic is at the output of each ALU. The logic decides whether to mark the pixel with either

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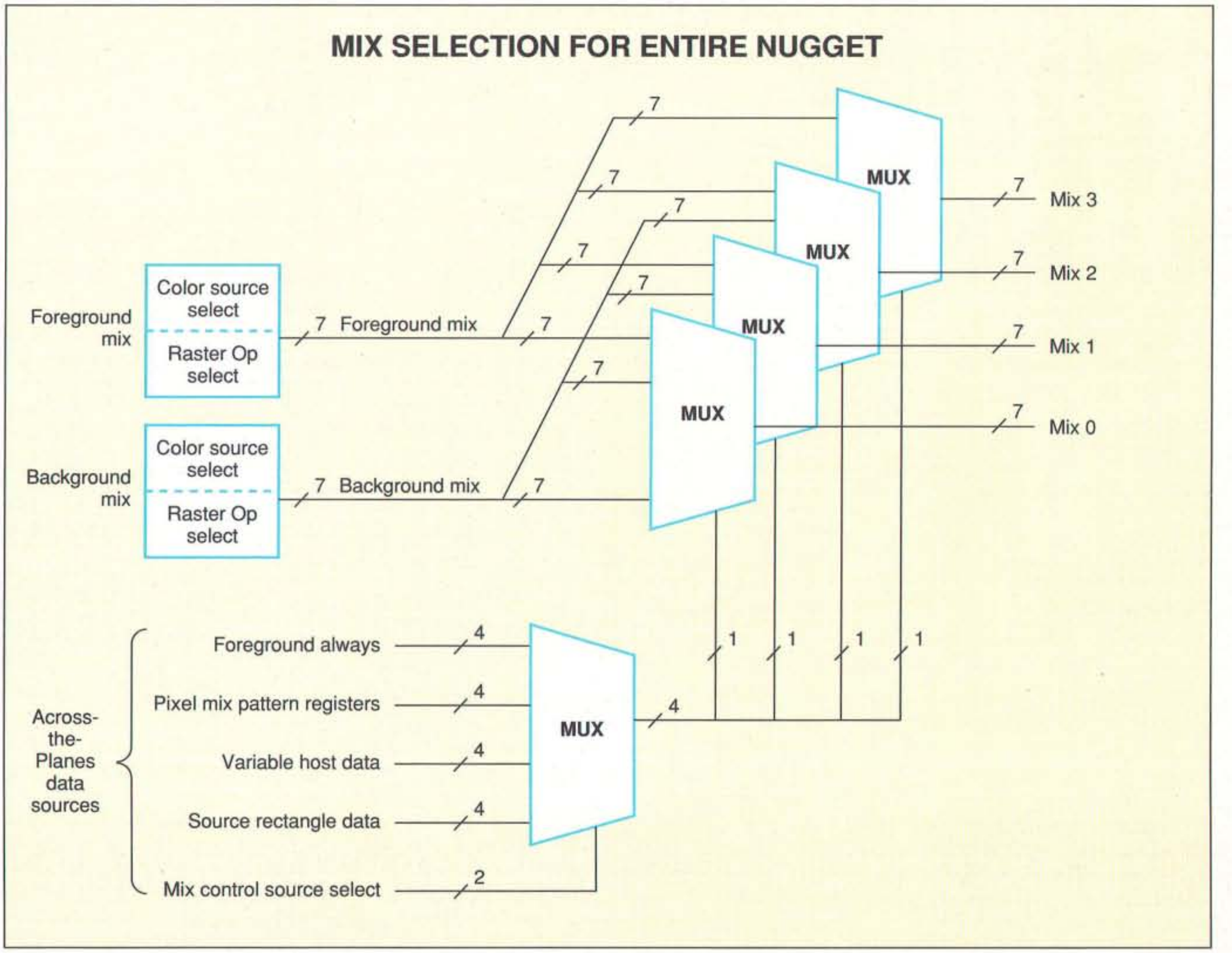

Figure 6: *Two mix registers (Foreground and Background) have full access to all Raster Ops and source data and, through multiplexing, control all 4 pixels of a nugget.*

the new pixel value from the ALU or the old pixel value (i.e., no change), or to set the pixel value to 0.

The Color Comparator decides whether to mark a pixel with a new color value (the ALU output) or to simply leave the old color in the pixel. This decision is based on a magnitude comparison of the old color data in the pixel (the destination data) against the color data value loaded into the Color Comparator register. Only write-enabled planes are compared.

IBM refers to this feature as *underpaint*. With it, you can create a foreground image (e.g., jail cell bars) on the screen with color indexes in a certain range (above 250, for example). You can also create another image (e.g., a convict) in off-screen memory, using indexes less than 250. You can now move the convict around inside the cell (underneath the bars) by using a single Copy Rectangle command to BLT the convict into each new position.

You can use the Bounded Area Fill logic to fill irregular areas with new pixel data. After you have drawn the outline using the Outline command, you use the Fill logic with an X-Rectangle or Copy Rectangle command that completely encompasses the outlined area. You can select whether to overwrite, erase, or not touch the outline as you make the fill.

At the beginning of each new scan line of the destination rectangle, the Fill logic is reset to choose the old (destination) data. As the shape engine sweeps the Current Position from left to right, the logic examines the read-enabled color planes of each pixel for all 1s, representing the boundaries of areas to be filled with new pixel data. Each time it encounters all 1s, the shape engine toggles the new/old pixel data, so that new pixel data is enabled inside the boundary while the old pixel values remain outside the boundary.

Just Whetting Your Appetite

As you can see, the 8514/A architecture is an impressive graphics platform. Even though this article has stayed mostly at the conceptual level, I hope it encourages you to do some programming for the 8514/A. You will need more details in order to implement this information. Specification sheets for 8514/A processors are available from Chips & Technologies and other 8514/A manufacturers. ■

Ben Cahill is senior design engineer at Chips & Technologies and lives in Los Gatos, California. He can be reached on BIX c/o "editors."

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PART 2

THE SCSI BUS

SCSI may well succeed as a general-purpose desktop I/O bus

In last month's Under the Hood, I described the history, basic concepts, and low-level signals of the SCSI bus. This month, I'll conclude my treatment of SCSI by discussing how the bus facilities are used by the higher layers of the standard. I'll also cover the SCSI common command set, the common access method (CAM), and SCSI-2. Finally, I'll talk a bit about some of the SCSI devices on the market.

A Sample Transaction

When I left off last time, I'd just described the *phases* of the SCSI bus, which determine which way data is being transferred and for what purpose. Figure 1 shows one way that these phases can be grouped into a *transaction*, a sequence of phases that starts and ends in the BUS FREE phase. Interestingly, it's the target—not the initiator—of the SCSI transaction that determines the sequence of phases from the command it has been asked to process.

The initiator finds out what phase the bus is in by watching the SCSI control lines. Unfortunately, as is the case in the original Shugart Associates system interface (SASI) bus, it's possible for more than one of the lines that determine the phase (i.e., BSY, SEL, C/D, I/O, and MSG) to change during a phase transition.

Thus, the SCSI bus requires lots of deskewing and settling delays to prevent "false" states from being detected when all the lines don't change at the same time. (IPI, the intelligent peripheral interface I discussed last month, avoids this problem by encoding its phases with a "gray code," in which only one control line changes during each phase transition.)

Figure 1 reveals another subtlety of the SCSI bus's timing: The edges of the REQ and ACK pulses are used in different ways, depending on the direction of data transfer. During the COMMAND phase, when data flows from the initiator to the target, data is considered to be valid from the start of the ACK pulse and held until at least the end of the REQ pulse. But during the DATA IN, STATUS, and MESSAGE IN phases, when data flows from the target to the initiator, the data is valid from the start of the REQ pulse and held until at least the start of the ACK pulse.

SCSI Commands

The original SCSI standard was developed at a time when each equipment manufacturer used a different set of commands for its devices. SCSI therefore had loose requirements for commands, and almost none of them were mandatory. However, the specification did specify classes and required formats for the commands.

Each SCSI command is sent to a device as a *command descriptor block*. The first byte of each block is the operation code, which in turn has two fields: a *group code* (contained in the 3 most significant bits and which indicates the type of command and the number of bytes it contains) and a *command code* (which specifies the command itself).

Figure 2 shows the layout of a 6-byte (group 0) command descriptor block. The eight groups of command codes are divided by length. Group 0 contains 6-byte commands, groups 1 and 2 contain 10-byte commands, and group 5 contains 12-byte commands. The other groups are either reserved or vendor-specific. A command descriptor block always ends with a *control byte*, which contains flags that allow several commands to be linked together in a sequence and sent all at once.

Command linking is a powerful SCSI feature. By sending a sequence of linked commands, an initiator can avoid the delays involved in waiting for a command to complete, rearbitrating for the bus, and issuing another command. For instance, suppose the host wants to find a disk block that contains a certain byte sequence and read it into memory. If it sends a SEARCH DATA EQUAL command followed by a READ command to an intelligent SCSI disk drive, the drive will automatically return the correct data with no further intervention.

Status Bytes

Each command returns a status byte on completion, as shown in the table. A good status indicates that the target has successfully completed the command.

A *check condition* status indicates that some kind of error has occurred. The initiator has to poll the target to determine the nature of the error, so the target has to keep track of the status condition that caused the error, even if it subsequently goes away. The SCSI-2 specification has a formal name for this situation: a *contingent allegiance condition*.

A *condition met* status indicates the success of an operation that looks for data.

A *busy* status indicates that the target is unable to accept a command but will be able to sometime in the future.

An *intermediate* status indicates the completion of one of a series of linked commands. The intermediate condition met status indicates that a linked command found the data sought.

A *reservation conflict* status is returned if an initiator attempts to access a device, or part of a device, that has been reserved for exclusive use by a different initiator.

A *command terminated* status (with SCSI-2 only) is returned when the target

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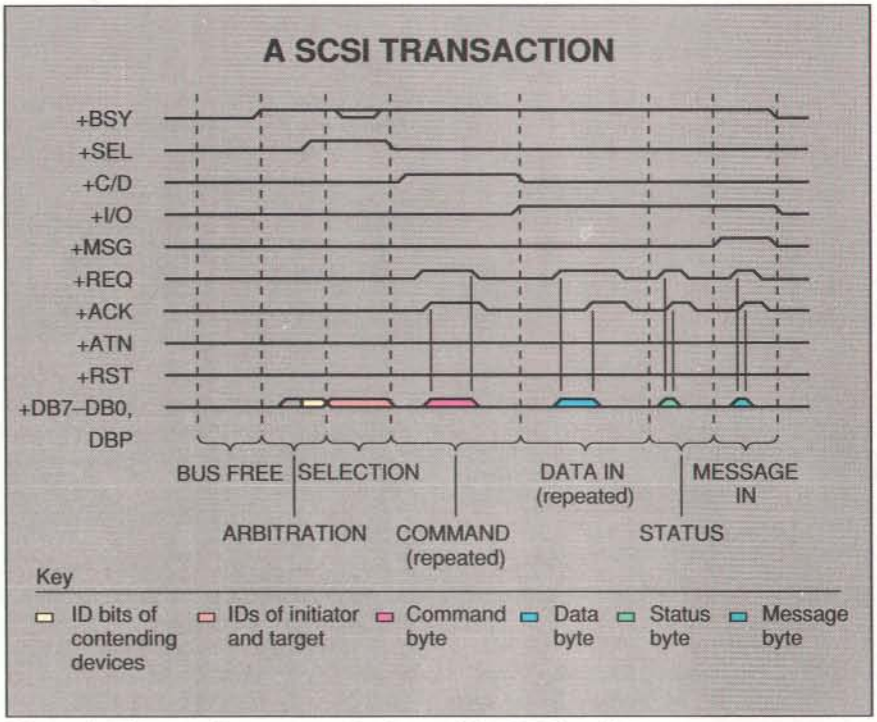
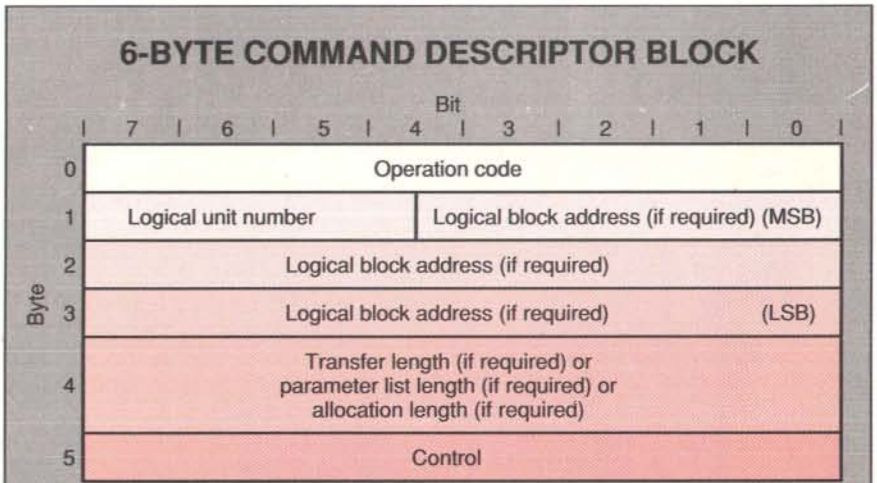


Figure 1: *The signals present on the lines of the SCSI bus during a transaction. This particular transaction, which might occur when a host reads data from a disk drive, starts (as all transactions do) in the BUS FREE phase. It progresses to the ARBITRATION phase (optional in SCSI-1, but required in SCSI-2), during which the host (i.e., the initiator) gains control of the bus, and the SELECTION phase, during which the target device is selected. Multiple COMMAND phases (only one is shown) transfer the bytes of the command, and one or more DATA IN phases return data to the host. The transaction ends with the transfer of status and message bytes. Shaded areas represent transitional states.*



6-BYTE COMMAND DESCRIPTOR BLOCK

Byte	Bit 7	6	5	4	3	2	1	0
0	Operation code							
1	Logical unit number			Logical block address (if required) (MSB)				
2	Logical block address (if required)							
3	Logical block address (if required) (LSB)							
4	Transfer length (if required) or parameter list length (if required) or allocation length (if required)							
5	Control							

Figure 2: *The layout of a 6-byte command descriptor block. The larger formats (i.e., 10- and 12-byte commands) are similar but leave room for larger addresses and transfer lengths. Some commands require a parameter list, which contains additional information required to execute the command, to be sent via a DATA OUT phase before the command starts executing. If this is the case, the target requests the necessary number of bytes during that phase.*

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terminates execution of one or more commands at the initiator's request.

A *queue full* status (SCSI-2 only) is returned when a device is unable to fulfill a request to queue a command.

The Common Access Method

The original SCSI specification, ANSI standard X3.131-1986, suggested formats for many commands but required the implementation of almost none of them. In fact, only a single command—REQUEST SENSE—was mandatory for every device. The result was confusion; few controllers could plug and play with any SCSI system.

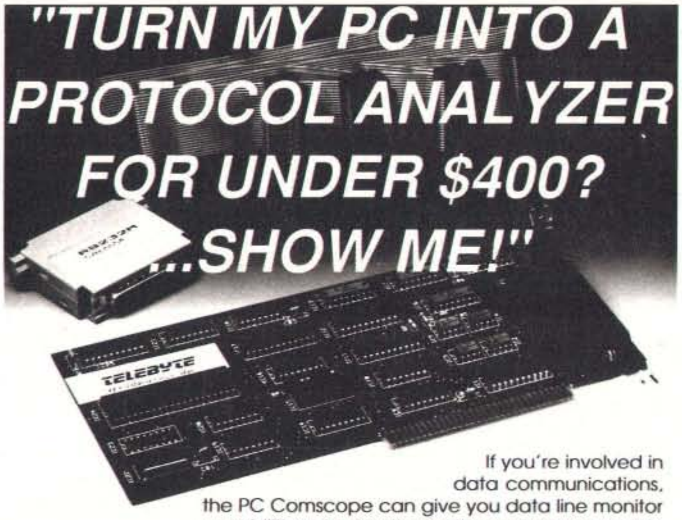
Even before ANSI formally approved the SCSI specification, vendors and users sought to rectify this situation. From the fall of 1985 through the spring of 1986, a working group met to hammer out a document specifying a common command set, listing commands that all vendors of each kind of peripheral device should implement. This document became a de facto standard, and much of it was incorporated into the SCSI-2 specification.

The CAM committee met to address a similar problem that prevented SCSI from being used efficiently in many computer systems. Some hardware platforms (e.g., the IBM PC) make no system-wide provisions for different devices to use the same host adapter. Thus, if you equip your system with a CD-ROM player, a tape backup unit, an external hard disk drive, and a WORM (write once, read many times) drive, each one might use SCSI—but unless the software drivers for these peripherals can share the SCSI adapter gracefully, you'll fill the slots in your backplane with redundant adapters.

Manufacturers like Sun and Apple developed their own solutions to this problem: the Sun Common SCSI Architecture and the SCSI Manager, respectively. But each solution is vendor-specific and requires software to be completely rewritten for each machine. One goal of CAM is to provide similar interfaces across hardware platforms, minimizing the effort involved in creating device-driver software for a new system. Figure 3 shows a model of the CAM environment.

The CAM committee is also polishing a standard called AT Bus Attachment (ATA), which specifies how a peripheral controller can emulate the original IBM AT hard disk drive interface (the WD-1003). This is important because a lot of system software—including IBM's version of OS/2—requires the hardware to

continued



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look precisely like a standard IBM machine in order to run. ATA and EATA (the Extended AT Bus Attachment specification) show vendors how to create interfaces for SCSI, ESDI, and other kinds of peripherals and cause the operating-system software to "accept" them as if they were the more usual adapters.

If CAM is extended to its logical conclusion, it may be used as a complete computer I/O system rather than just a way to share SCSI devices.

Apple SCSI: Not Quite Standard

Apple was among the first major microcomputer manufacturers to implement SCSI. Unfortunately, as many experimenters and systems integrators have found out, "Apple SCSI" isn't the same as many other manufacturers' SCSI, and peripheral vendors often need to prepare special versions of their products to accommodate quirks of the Macintosh.

What's different about Apple SCSI? The first difference revolves around a SCSI feature called the *unit attention condition*, which was optional in the original SCSI specification and is mandatory in SCSI-2.

A device on the SCSI bus enters the unit attention condition whenever it or the bus has undergone a hard reset, a power-on reset, or a reset generated by a BUS DEVICE RESET message. It can also happen in certain other cases—for instance, when the medium on the device is changed.

When a device is in the unit attention condition, it wants to tell the next initiator that contacts it that the event occurred. To do this, the device examines the next command received and checks to see if it's one of two that poll the status of the device: INQUIRY and REQUEST SENSE. If the command is one of these two, there's no problem; the device sends back its status (which reflects the event) and exits the unit attention condition.

What if another kind of command arrives? In this case, the device refuses it and sends back a check-condition status code, a signal that the initiator should look at the device's status before issuing any other commands. The status code is sent back only once; if the initiator chooses to ignore the condition, it can reissue the command and it will be executed.

This feature, which seems like a sensible way to do things, causes boot-up failures when used with Apple's current ROMs. At boot-up time, the ROM code tries to read bootstrap information from each SCSI device on the bus. Alas, it tries each device only once, going on to the next device if the command is refused. Then, if it can't read from any of the devices on the SCSI bus, it resets the bus (causing all the devices to reenter the unit attention condition) and tries again.

To accommodate this quirk of Apple SCSI, manufacturers have produced special versions of their drives that either don't implement the unit attention condition or provide a means of turning it off, usually via a jumper on the controller board.

Apple SCSI has some other idiosyncrasies as well. Some of the earlier SCSI Macs didn't provide a way for the SCSI controller to generate interrupts on the host CPU, so it wasn't possible to make the 68000 handle the SCSI bus's REQ/ACK handshaking properly. Apple therefore implemented "blind" SCSI reads and writes, which ignore the handshaking lines on the assumption that the remote device will always be able to handle transfers at a certain data rate. This assumption holds for most devices. But in some cases, the software may have to poll the SCSI port instead.

Termination on Apple SCSI is also unusual. All SCSI buses must be terminated at both ends. However, some Macs (e.g., the Mac SE) have had power supplies that were too weak to power a terminator. For this reason, you may need to add one or two external terminators (but never more than two) when connecting SCSI equipment to a Mac. The somewhat complex rules for how and when to add them take a few pages in Apple's manuals.

STATUS BYTE CODES

Each command returns a status byte on completion.

Bit								Status
7	6	5	4	3	2	1	0	
R	R	0	0	0	0	0	R	Good.
R	R	0	0	0	0	1	R	Check condition.
R	R	0	0	0	1	0	R	Condition met.
R	R	0	0	1	0	0	R	Busy.
R	R	0	1	0	0	0	R	Intermediate.
R	R	0	1	0	1	0	R	Intermediate condition met.
R	R	0	1	1	0	0	R	Reservation conflict.
R	R	1	0	0	0	1	R	Command terminated (SCSI-2 only).
R	R	1	0	1	0	0	R	Queue full (SCSI-2 only).

SCSI-2 and Beyond

SCSI-2 evolved from the original SCSI specification (SCSI-1) as a way to provide more features, higher data transfer rates, and greater compatibility among SCSI devices. Unlike SCSI-1, SCSI-2 makes parity, arbitration, a basic set of SCSI messages, and the common command set mandatory. It standardizes the way bus terminators are powered and provides two optional enhancements that can greatly increase throughput: fast SCSI and wide SCSI.

Fast SCSI dramatically increases the synchronous transfer rate over a SCSI bus. It lets the target and the initiator negotiate transfer rates of up to 10 million transfers per second, compared to a maximum of 4 million transfers per second under SCSI-1. This option works only on

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Sources

The SCSI specification is available for $25 from the American National Standards Institute, 1430 Broadway, New York, NY 10018, (212) 642-4900.

The X3T9.2 committee working documents, CAM committee documents, and the most current draft of the SCSI-2 specification are available for downloading from the SCSI BBS at (316) 636-8700 (300, 1200, or 2400 bps; 24 hours).

A paper copy of the SCSI-2 draft specification is available for $60 from Global Engineering Documents, 2805 McGaw Ave., Irvine, CA 92714, (800) 854-7179 or (714) 261-1455.

differential cabling, however; single-ended SCSI doesn't have good enough transmission-line characteristics to support it.

Wide SCSI increases the width of the SCSI data path to 16 or 32 bits. The original SCSI cable becomes the A cable, and a new one, which carries additional data lines, is called the B cable. When wide and fast SCSI are used together, transfer rates of 40 megabytes per second are possible. To handle tight spaces and increased numbers of pins, SCSI-2 adds high-density connectors.

SCSI-2 provides explicit support and standard commands for CD-ROMs, scanners, WORM and read/write optical disks, "jukebox" disk changers, and communications ports.

By the time you read this, the SCSI-2 specification will have finished a four-month review period. In the meantime, work is already starting on SCSI-3, which may include such innovations as fiber-optic SCSI and automatic configuration.

Manufacturers, however, haven't waited for the SCSI-2 specification to receive final approval before implementing it. Many disk drive manufacturers, such as Imprimis Technology, have already begun to sell drives billed as SCSI-2-compatible (although I'm not aware of any that implement 16- or 32-bit data paths yet).

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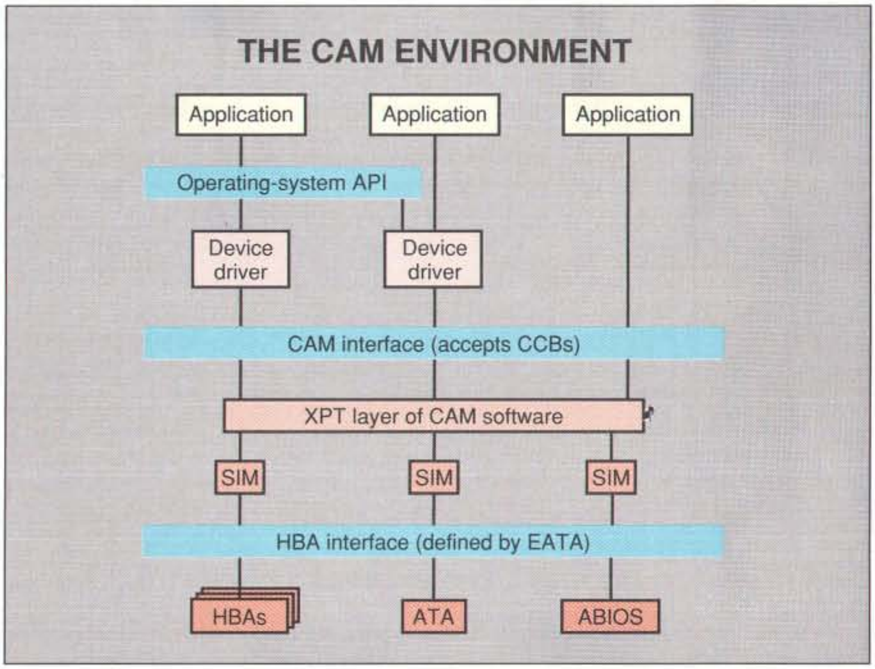

Figure 3: *How the common access method provides a common interface to the SCSI bus and, possibly, even non-SCSI peripherals. The operating system, a device driver, or an application sends a CAM control block (CCB) to the transport (XPT) layer of the CAM software. The XPT routes the request to another layer of software, the SCSI interface module (SIM), which in turn talks to the host bus adapter (HBA) or other hardware/software modules. EATA is the Extended AT Bus Attachment specification. (Figure adapted from information supplied by Dal Allen of ENDL Consulting and the CAM committee)*

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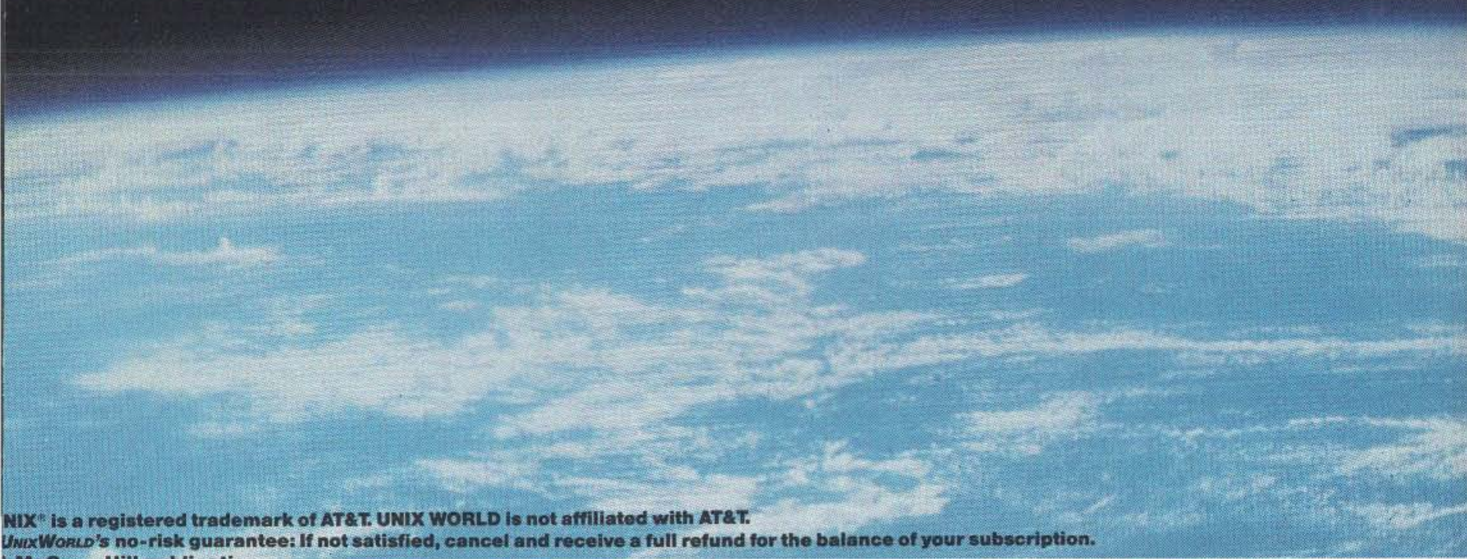

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SCSI in the Real World

SCSI is becoming more and more pervasive as a standard for interfacing different vendors' hardware to a wide variety of peripheral devices. Chances are that if you own a Sun workstation, a Macintosh, a NeXT cube, an Atari ST, or an Amiga with a hard disk drive, you're already using SCSI—although you may not know it. And while the IBM PC never "officially" supported SCSI while IBM was in control of the standard, many PC-compatible devices do in fact use the SCSI bus.

All models of Iomega's Bernoulli Box (also resold by Tandy) use SCSI. Two new high-density 3½-inch floppy disk drives—Insite Peripherals' Floptical drive and a competitive all-magnetic drive from Brier Technology—are SCSI devices. Many intelligent caching disk drive controllers, especially those intended for network servers with large numbers of disk drives, use SCSI to talk to the drives. Even IBM, a longtime holdout in the SCSI world, sells a SCSI-compatible WORM drive (manufactured by Matsushita) and has demonstrated a bus-master SCSI adapter for the Micro Channel. Almost all WORM and CD-ROM drives interface to hosts via SCSI.

The range of SCSI peripherals isn't limited to disk drives. Many cartridge and nine-track tape units, especially high-end models, use SCSI. Apple offers a version of the LaserWriter—the IISC—with a SCSI. This eliminates the main bottleneck in Mac systems that have to print large bit maps: the relative slowness of the LocalTalk interface.

Because Apple's low-end Macs have one or no internal slots for peripherals but do have SCSI adapters, vendors of other kinds of devices (e.g., network adapters) have begun to provide products with SCSI adapters. If this trend continues SCSI may succeed as a general-purpose desktop I/O bus.

Compatibility

With the advent of the common command set, CAM, and SCSI-2, SCSI peripherals should be able to plug and play with virtually any system. Before they can, however, manufacturers will need to understand, embrace, and implement these new standards. For instance, Apple is aware that the software that manages the SCSI ports on the Mac isn't compatible with all devices (see the text box "Apple SCSI: Not Quite Standard" on page 294). Apple should catch up with the rest of the industry when System 7.0 ships sometime this year.

The future of SCSI looks bright, as more and more manufacturers incorporate it into their systems. Even IBM is expected to launch SCSI storage products for its PS/2 line this year. But whether Big Blue joins the party or not, it's clear that this worthy descendant of one of IBM's own I/O buses is likely to remain a popular interface option for a long time to come. ■

ACKNOWLEDGMENT

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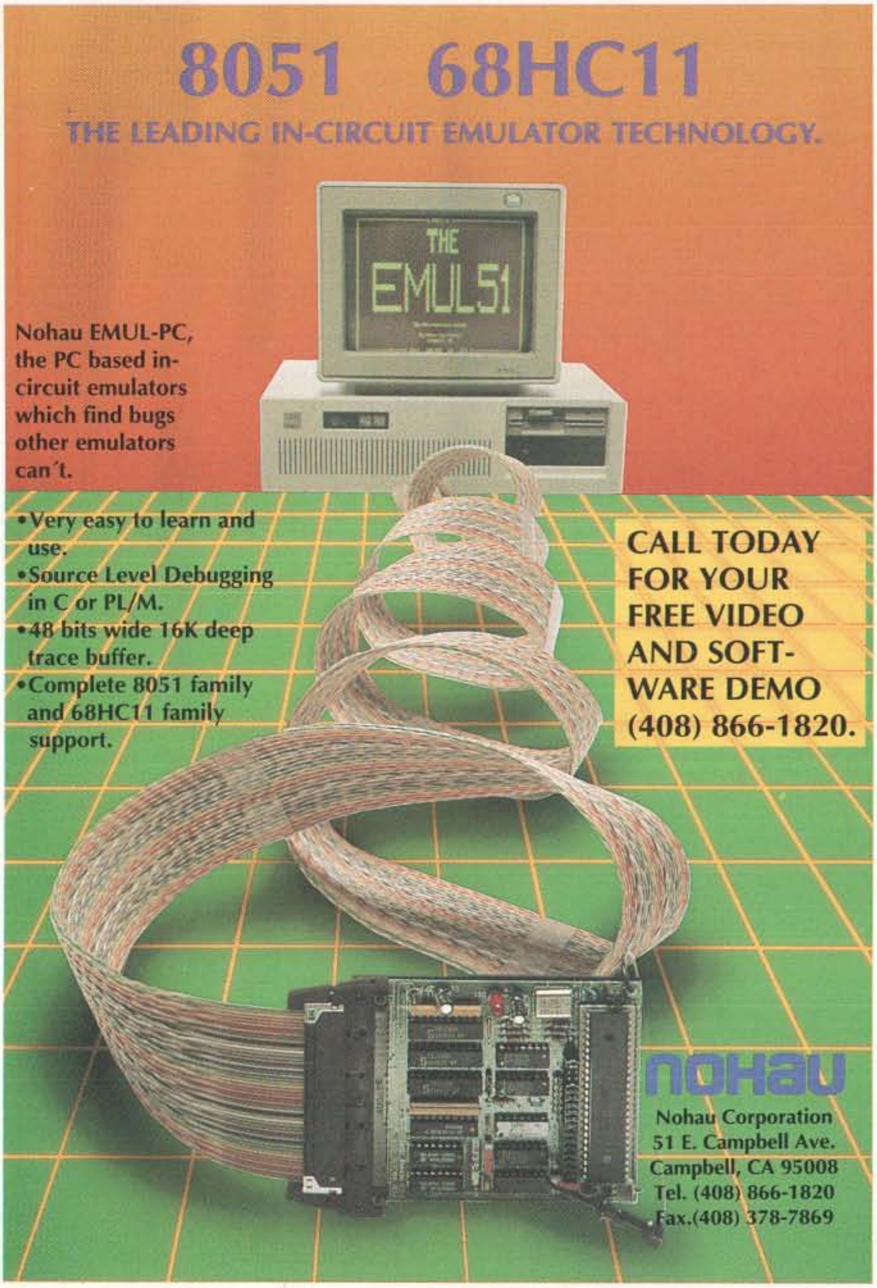

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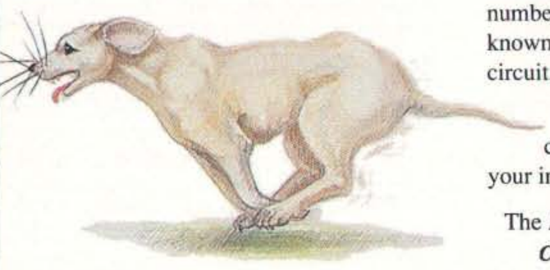

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Rick Grehan

FOREIGN FILE SYSTEMS

Using special file systems from within standard file systems

A standard file system may not be well suited for a particular application. However, it is perfectly logical and quite possible to set up a partition on your hard disk that contains a unique (foreign) file system and to access this partition from your standard operating system. You gain an optimal file system for the application without changing operating systems.

Encounters with Foreign File Systems

The impetus for this project came from two directions at different times. One was a note that I saw circulating on one of the networks I infrequently explore, in which a hopeful user spoke of his search for a file system that could handle some data he had received on magnetic tape. The data included some digitized high-resolution photos that were stored in files so large that most file systems available on personal computers would be unable to handle them.

The other was a demonstration given by a software company that had developed a program for real-estate agents. This program was a database application running under PC-DOS, with the addition of digitized photos of the properties that you could display on a separate, high-resolution monitor. Consequently, each database record not only carried the written information associated with a property but also carried a pointer off to another file where the software could locate the digitized images.

The images file wasn't kept in a DOS directory; it wasn't even kept on a DOS partition. The designers of the software had decided that the structure of the DOS file allocation table (FAT) was inadequate for handling the number and size of files that the pictures required. They therefore designed their own file system, optimized for their particular requirements, and kept it in an alternate partition on the hard disk.

That's it: A foreign file system that is nonetheless accessible from PC-DOS. You can divide your hard disk into a DOS partition—so that you can keep all the programs you already have—and a foreign partition whose directory structure is optimized to whatever application you need. Of course, if you are really desperate for space you can buy a separate hard disk and fill it up entirely with the foreign file system.

This idea isn't novel. Variants of it have been in use for some time. QuickShare (from Compatible Systems of Boulder, CO) is a software/hardware product that lets a Mac Plus (or higher) share a hard disk with a PC. The hardware end is a SCSI adapter that plugs into the PC, and a cable that connects this to the Mac. You build one large file on the PC that becomes the volume that the Mac sees, and the data inside the PC file is a complete Mac volume: bit maps, directory B-tree, and all.

Another example is the Definicon DSI-32 Unix board that I have installed in the PC with which I am writing this column. One of my hard disks is actually divided into three partitions. The first is an MS-DOS partition, from which the system boots. The other two are Unix partitions; one holds the Unix file system, and the other is a swap region for supporting the system's virtual memory.

continued

ILLUSTRATION: ROBERT TINNEY © 1990

Something New

This month I decided to put together the rudimentary routines for supporting a separate file system on a PC's hard disk. I didn't want to just put together another version of a general-purpose file system; I wanted to build a file system that was customized to a particular class of applications. The most logical application for a hard disk was undeniably some form of database system. It therefore seemed reasonable to concentrate on a file system geared solely to supporting databases. Such applications are becoming more popular as networks continue to spread. They are particularly appealing to small and moderate-size companies where employees spend most of their time browsing only two or three large database files.

While many of us couldn't conceive of life without a hierarchical file system of directories and subdirectories, lots of PCs execute only vertical applications. Most of the customers I worked for in my data-processing days purchased machines to handle only accounting or inventory functions. These people didn't need nested directories. The number of data files being manipulated was often less than 50—certainly less than 100. Any departmentalization of data took place inside the database files. Therefore, the file system I designed is more or less "flat." You can segregate files into directory areas, but there are no directories within directories.

Database systems usually see a file as

continued

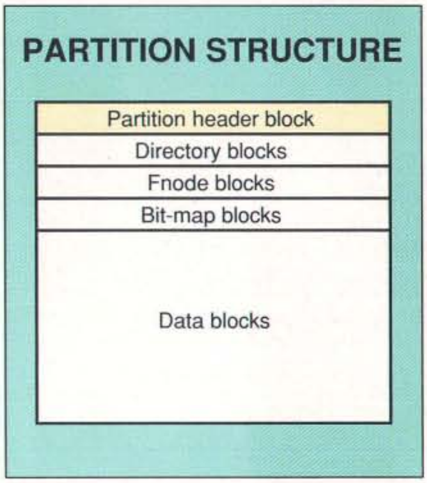

Figure 1: *The partition header block is always the first 1024 bytes of the partition and carries parameters that define the other regions' sizes and locations.*

PARTITION HEADER BLOCK FORMAT

Table 1: In my file system, the partition header block is always the first block on the partition and carries fields that define the locations and sizes of the other region.

Offset	Size (bytes)	Description
0	4	Total partition size in 512-byte sectors.
4	2	Sectors per track.
6	2	Maximum number of heads.
8	4	Starting block number of directory area.
12	4	Starting block number of fnodes area.
16	4	Starting block number of bit-map area.
20	4	Starting block number of data area.
24	4	Number of active entries in the directory.
28	4	Number of active entries in fnodes area.
32	400	Passwords for 50 directory areas (a password is up to eight characters).

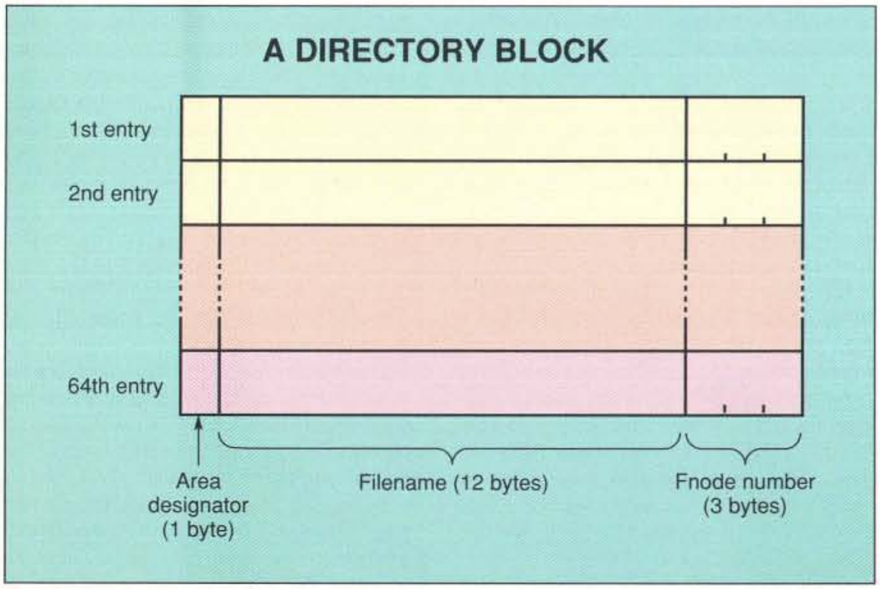

Figure 2: *Each directory block holds up to 64 directory entries.*

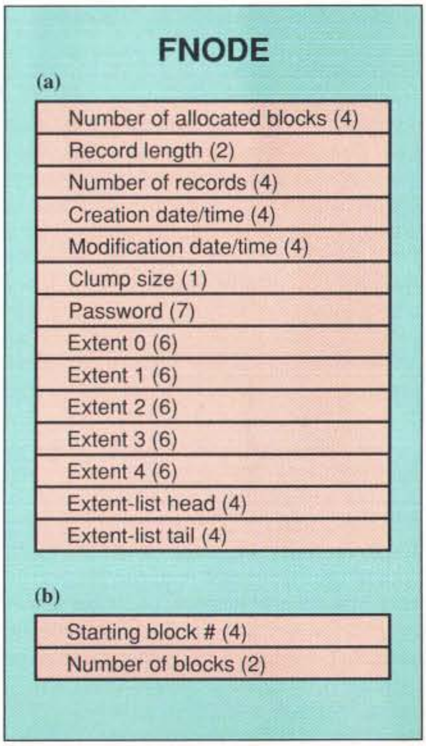

Figure 3: (a) *The fnode holds a file's vital characteristics. The file's data can be found by following the extent entries.* **(b)** *The format of an extent.*

Direct to Disk

Sometimes you find that you have to sidestep the operating system and speak directly to your hard disk—an act that leads you nervously past a host of warnings into the world of sector editors and single-bit surgery. Usually, you only visit this place on rescue missions sent after a lost file that has failed to report in. This is also where you find the fundamental operating system and BIOS calls you need if you want to customize your file system.

IBM PC

In the PC world, if you abandon the layer of directories and files for deeper reaches, you find two levels. In the uppermost layer, you're still under the influence of MS-DOS (assuming that's the operating system you're running), but you no longer see the complex structures of directories and files. The disk has become a linear series of sectors stretching out to a horizon that usually ends at around 32 megabytes.

You access the disk using interrupts 25H and 26H (where 25H reads the disk and 26H writes the disk). Both interrupts require similar arguments: The AL register holds a drive specifier (0 for A, 1 for B, and so on), CX holds the number of sectors to transfer, DX is the beginning sector number, and DS:BX point to a buffer in memory that either holds the data to be written or will accept data that will come off the disk.

Notice that I said "around" 32 megabytes. This is the limit to the size of a hard disk partition if you use the MS-DOS default of 512-byte sectors. In fact, some atypical versions of MS-DOS extend the size of a partition by defining sector sizes of larger than 512 bytes. You have to take this into account when you ask the above interrupts to read some sectors for you.

How, then, do you find the number of bytes per sector? Perhaps the easiest way is through interrupt 21H, function 36H. (Usually, you call this function to determine the amount of total and available disk space on a drive.) This function expects a drive specifier—such as I described above—in the DL register. When function 36H returns, you'll find (among other things) the number of bytes per sector in the CX register.

Beneath the DOS interrupts are the BIOS interrupts that talk to the hard disk drive controller. Here, all vestiges of a governing operating system have vanished. At this level, the physical geometry of the hard disk becomes visible. Interrupt 13H, function 02H, lets you read sectors from the hard disk, given that you've specified the starting sector's location. Now, however, a sector's position is given by a head number, a cylinder number, and a physical sector on the cylinder. (See table A for a complete description of this function.) As the system reads sectors from the disk, it first advances through sectors, then heads, then cylinders. Interrupt 13H, function 03H, is the BIOS function for writing to a hard disk.

Accessing the disk at this level demands that you know how many heads, cylinders, and sectors per cylinder it has. You can find this information in the disk's boot sector, conveniently located at head 0, cylinder 0, sector 0. The pertinent data is the number of sectors in the volume (at offset 19), the number of sectors per track (at offset 24), and the number of read/write heads (at offset 26). (You can also retrieve this information through the BIOS 13H interrupt. Subfunction 8 of this interrupt will return the maximum head value in DH, and the maximum cylinder and sector numbers combined in the CX register as described above.) For more information on this, see my May 1989 column.

Macintosh

There are two stories to cover on the Macintosh, since that system recognizes two kinds of drive controllers. In order of appearance, the disk driver comes first, followed by the SCSI manager.

You access the Macintosh disk driver through the device manager. The disk driver controls the internal, as well as any external, floppy disk drives. More important, it controls the HD20 hard disk drive. (Some people—those who don't have an HD20 hard disk drive—may find the disk driver interesting only from a historical perspective.)

Here's a simple example: reading one sector from a disk. You first need the driver reference number. For floppy disk drives, this is −5; for the HD20, this is a −2. (The system uses this reference number to form a pointer into the unit table, where the Mac keeps a list of handles to device drivers and active Desktop items.) Then you need the drive number (1 for the internal or hard disk drive, 2 for the external floppy disk drive), a byte offset, and a pointer to a

continued

INTERRUPT 13H CALLS REGISTER SETTINGS

Table A: The contents of the registers when you access the hard disk using interrupt 13H: The top half is function 02H-read, and the bottom half is function 03H-write.

Read hard disk

AL = 02H
AH = The number of sectors to read (128 maximum)
CX = Cylinder/sector address *
DH = Head number
DL = Hard disk number (80H is first hard disk drive; 81H is second drive)
ES:BX = Address of buffer to receive data

Write hard disk

AL = 03H
AH = The number of sectors to write (128 maximum)
CX = Cylinder/sector address *
DH = Head number
DL = Hard disk number (see above)
ES:BX = Address of buffer to write from

* The low 6 bits of the CL register hold the physical sector number. The CH register holds the low 8 bits of the cylinder number, and the top 2 bits of CL hold the top 2 bits of the cylinder number.

BIX CALENDAR MARCH

Display this month's BIX activities

MA H

Exchange Updates

Amiga Exchange—A new series of CBix sessions has begun in the Amiga Exchange this month, permitting on-line discussions and activities that all Amiga users will want to take part in. Tuesday night topics cover program development and system interface design. Wednesday nights are special-event nights (look for system bulletins for upcoming scedules). Thursday nights will feature discussions of existing or projected Amiga applications and their implementation. And on Saturday and Sunday nights, you're invited to come in and chat on any Amiga-related topic you wish. All CBix events begin at 10 PM EST. (join amiga.user/cbix) Look for a schedule of upcoming topics covering games and education/educational software in amiga.user, too.

IBM Exchange—It's back-to-school at "Big Blue U." The IBM Exchange is offering classes on a variety of computer-related subjects. (join ibm.class)

CBix sessions are held every weeknight at 10 PM EST (look for a schedule in info.cbix). If you're a novice or intermediate IBM user, you'll definitely want to join the Wednesday night discussions. (join ibm.exchange/cbix)

Mac Exchange—Can life with one megabyte or less be meaningful in the future? In March, the Macintosh Exchange will attempt to answer such questions as "Where is the Mac Plus heading?" "What kind of machines will replace it?" "Will putting system resources in ROM make things easier for the one-megabyte-user?" "Will you need two megabytes or more to use the forthcoming System 7.0?"

Elsewhere in the Mac Exchange, our on-line C tutorial will continue in mac.novice/tutorial. (And remember, you can jump into the tutorial at any point simply by reading past messages. Things don't scroll off this exchange.) We'll also be looking forward to the upcoming Spring Developer's Conference, and what its proceedings may hold for Mac-users.

Writers Exchange—Could an Irish novelist and an Ionian Greek poet nearly 2,700 years his senior really have more in common than a gift for writing mytho-epic poetry? And of their efforts to portray man always meeting himself as he walks through life (and which, therefore, have always begged comparison), isn't Joyce's *Ulysses* more the epic, and Homer's *Odyssey* more the novel in verse? And for that matter, did Homer really *write* the *Odyssey?* Discuss these classics and more — in English or Latin — in writers.talk/learn.classix.

On a more practical level, is there really a trade-book crisis? See writers long messages, message 331.

Interactive Games Exchange—Sundays, 9 PM EST — Poetry, art, music and stories from by-gone days to yet-to-come days are featured in this conference. (join fun.n.games/game.room)

Sundays, 9:30 PM EST — Learn about role-playing games on line and off line at Fantasy Foundation College. (join ff/ff.col)

Mondays, Thursdays, and Saturdays, 9 PM – Midnight EST — Check into the Meade & Mirth Inn and enjoy free-form, role-playing games that take you back to the Middle Ages — and sometimes far into the future. (join mnm/inn)

Tuesdays, Wednesdays & Saturdays, 9:30 PM EST — Enjoy real-time fantasy role-playing games as well as message-based player interaction in Ledinworld, the Advanced Dungeons & Dragons center of the IGX. (join lworld/ledinworld)

Thursdays, 10:15 PM EST — Break in on Pandemonium, the contemporary parlor game and other social activities in the "game.room." (join fun.n.games/game.room)

Fridays, 9 PM EST — Begin your T.G.I.F. nights in the pursuit of trivia. (join fun.n.games/game.room)

Fridays, 9:30 PM EST — Play a role in a variety of role-playing games. (join encounters/new.worlds)

BIX Conference News—Science Fiction Art has become a hot topic in the sf conference, and with the work of such artists as Vallejo, Frazetta, and Chelsey Bonstell in contention, you'll be tempted to wonder if a book can really be judged by its cover. (join sf/art)

Financial followers will be interested in these topics now being discussed in the financial conference: the financial aspects of collecting, specifying an "Ultimate Database" project, and soliciting comments from collectors about insurance and hobby management. (join financial/collector.corn)

Netware Technical Journal invites you to discuss LAN hardware and software. (join netware.tech)

Homeowners who want to discuss oil prices, insulation techniques, and any other topic of interest around the house now have a home on BIX. (join old.house)

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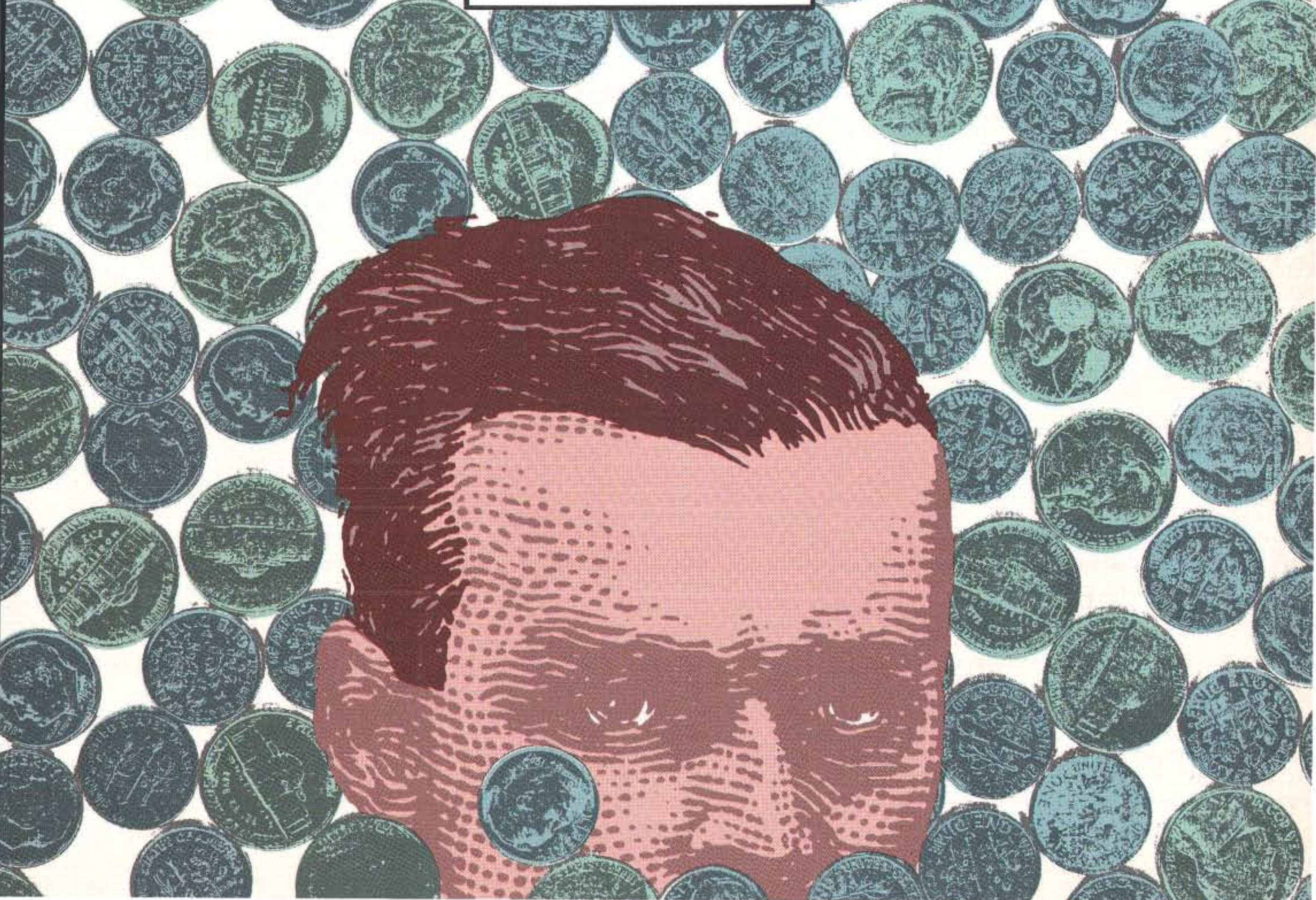


Listing A: *Preparing for an asynchronous read call.*

```
;The following equates are found in the SysEqu file for the assembler.
;I've added them here for readability.
ioQElSize     EQU   50      ;Size of I/O request block
ioDrvNum      EQU   22      ;Drive number
ioRefNum      EQU   24      ;Device reference number
ioBuffer      EQU   32      ;Buffer pointer
ioByteCount   EQU   36      ;Number of bytes to transfer
ioPosMode     EQU   44      ;Positioning mode
ioPosOffset   EQU   46      ;Positioning offset

;The following routine performs a read operation.
;On entry:
;       D1 = Number of bytes to read
;       D2 = Address of buffer to read into
;       D3 = Offset into device to read from (byte offset)
;       D4 = Drive number
;       D5 = Device reference number
;On exit:
;       D0 = Result of operation
;
;Make an I/O request block on the stack
        MOVE
L       #(ioQElSize/2)-1,D0
DDR1:   CLR.W     -(SP)
        DBRA      D0,DDR1
;Move request items into block
        MOVE.L    SP,A0               ;Address of block in A0
        MOVE.W    D5,ioRefNum(A0)
        MOVE.W    D4,ioDrvNum(A0)
        MOVE.W    #1,ioPosMode(A0) ;Absolute positioning
        MOVE.L    D3,ioPosOffset(A0)
        MOVE.L    D2,ioBuffer(A0)
        MOVE.L    D1,ioByteCount(A0)
;Perform the Read operating
        _Read     ,ASYNC
;Clean up stack
        ADD.L     #ioQelSize,SP
```

Listing B: *Preparing for and making a* `_SCSICmd` *call.*

```
;Building a command descriptor block
;for the Mac SCSI. We assume BLOCK is
;a longword holding the block number,
;and NBLOCKS is a byte holding the number
;of blocks to read. Register A1 points to
;a memory buffer where the command descriptor
;will be stored.
        MOVE.L    A1,A0             ;Save pointer to command descriptor
        MOVE.L    BLOCK,D1
        OR.L      #$8000000,D1      ;This is a READ command
        MOVE.L    D1,(A1)+
        MOVE.B    NBLOCKS,D1
        MOVE.B    D1,(A1)+
        CLR.B     (A1)+             ;Clear last byte
        CLR.W     -(SP)             ;Make room on stack for result
        MOVE.L    A0,-(SP)          ;Push command descriptor pointer
        MOVE.W    #6,-(SP)          ;Push command descriptor size
        _SCSICmd                    ;Call SCSI manager
        MOVE.W    (SP)+,D1          ;Get result
;The result of the command is contained in register D1.
```

buffer in memory into which data is read.

You put all this (and a little more) into a structure known as an I/O request block. The format of the request block varies depending on the call, but I've given sample code in listing A that shows offsets for those fields necessary to make a read call. You stick the address of the I/O request block into register A0 and then perform the I/O operation trap. The Mac does its work, and the result of the operation (whether it went A-OK, or an error occurred) appears in the D0 data register.

Notice that I've shown the asynchronous example of the call. This means that the calling program waits until the operation completes. The synchronous version allows I/O to proceed in tandem with other processing, but it requires that you include in the I/O request block a pointer to an I/O completion routine. This is a routine to which the Macintosh passes control when the operation finishes. It then becomes the job of the I/O completion routine to clean up any errors that have taken place and to pass on any relevant information (such as whether the request succeeded) to the program that originally requested the I/O operation.

Life got easier on the Mac with the advent of SCSI. Although the SCSI hardware for the Mac Plus is admittedly crippled, at least it works. Later versions of the Mac have more robust SCSI hardware. Best of all, the SCSI trap calls provide a programming interface that is consistent across all Macs.

If you've ever done raw I/O on a SCSI device, you know that dealing with the interface is a series of phases: selection, command, data, message, and so on. The Mac SCSI driver automates some of the handshaking that must take place along the SCSI bus. Still, just the simple example I gave earlier—reading one sector—is not a trivial exercise with a SCSI disk drive. Here are the steps:

Step 1: Gain control of the SCSI bus. Do this with the `_SCSIGet` command.

a collection of fixed-length records instead of a stream of bytes. Each of these records is composed of fields—dates, names, quantities, and so on—to which you assign a fixed maximum size. (If you're used to using Paradox or the database features of Lotus 1-2-3, for example, you should be familiar with these concepts. Records are rows in the table, and fields are columns.)

As a result, I made my custom file system record-based. When you create a file, you declare its record size from 1 byte up to 1024 bytes. You seek a position in the file by record number rather than by byte. Additionally, my file system does not automatically extend a file. If you attempt to write to a record past the last one in the file, you'll get an error. You must explicitly add records to a file to make it grow.

The overall architecture of the partition appears in figure 1. You can see that the partition is divided into five regions. First and most important is the partition header block (in my file system, a block is 1024 bytes and is usually composed of

Step 2: Select the device you want to read from (or write to). Use the `_SCSISelect` command for this. It expects a device number (also known as a SCSI ID) on the stack. Since a SCSI bus allows up to eight devices to be chained along a single cable, the device number serves to select which device to access. This number must be in the range 0–6 (it can't be 7, since that's the ID of the Mac itself).

Step 3: Perform the actual read command. Here's where things get tricky, because you've got to build a command descriptor block that SCSI itself will understand. Then you execute the `_SCSICmd` routine, passing it a pointer to this command block. I've provided a fragment of code in listing B that shows how to set up the stack and make the call. The structure of a command block is shown in figure A.

Step 4: Transfer the data. In step 3, you told the SCSI device to perform a read operation. Now you've got to transfer that over the SCSI cable and into the Mac. You do this by building a transfer instruction block, which is a small memory buffer holding a miniature program that directs the appropriate SCSI transfer command. Each instruction in the TIB is a 16-bit word followed by two 32-bit parameters. Listing C is an example of how to set up the TIB and issue a `_SCSIRead` command. If you were to write the miniature program in human-readable form, it might look like this:

```
scNoInc @buffer,#nbytes
scStop
```

This tells the `_SCSIRead` command to transfer `nbytes` to the address stored in `buffer`, and then stop. The `scNoInc` command tells `_SCSIRead` not to increment the buffer pointer by `nbytes` when the command completes. (Aside: Another version of the `_SCSIRead` command is called `_SCSIRBlind` for "read blind." The difference between the two is that `_SCSIRead` transfers data with handshaking across the bus, so there's no chance of lost information. `_SCSIRBlind` does no handshaking; it's faster, but you must make certain that whatever Mac and SCSI devices you're using can cope with one another's speed.)

Step 5: Wait for the command to complete. Listing D shows how to issue a `_SCSIComplete` call. You can specify how many ticks (one-sixtieth of a second) to wait before a time-out error is issued.

There—not so hard, was it? The procedure is similar when you have to issue a write command. As usual, for all the details I don't have room for here, you should refer to the *Inside Macintosh* chapters on the SCSI manager.

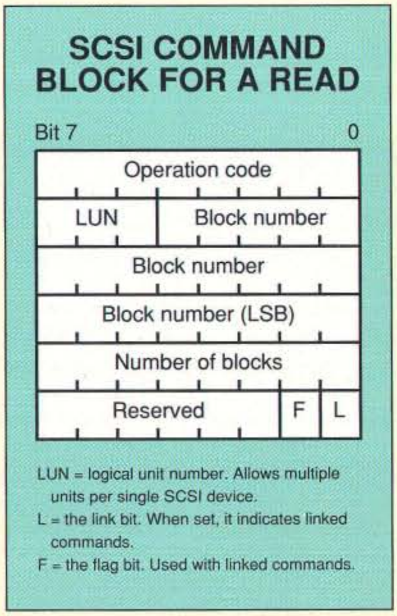

SCSI COMMAND BLOCK FOR A READ
Bit 7
0
Operation code
LUN
Block number
Block number
Block number (LSB)
Number of blocks
Reserved
F
L
LUN = logical unit number. Allows multiple units per single SCSI device.
L = the link bit. When set, it indicates linked commands.
F = the flag bit. Used with linked commands.

Figure A: *The SCSI command block format for a read command.*

Listing C: *Setting up the transfer instruction block and making a* `_SCSIRead` *call.*

```
;On entry:
; AO holds a pointer to the buffer to receive the data
; A1 holds a pointer to the transfer instruction block
; DO holds the number of bytes to transfer (512 in our example)
;On exit:
; DO holds the return code
        MOVE.L    A1,A2            ;Save transfer instruction block
        MOVE.W    #scNoInc,(A1)+   ;Don't increment buffer pointer
        MOVE.L    AO,(A1)+         ;Buffer pointer
        MOVE.L    DO,(A1)+         ;Number of bytes to transfer
        MOVE.W    #scStop,(A1)+    ;End of transfer instructions
        CLR.W     -(SP)            ;Space for result
        MOVE.L    A2,-(SP)         ;Pointer to transfer instruction block
        _SCSIRead                  ;Read the data
        MOVE.W    (SP)+,DO         ;Return code in DO
```

Listing D: *The* `_SCSIComplete` *that finishes the transfer.*

```
;Wait for SCSI command to complete
;On entry:
; AO - status buffer pointer
; A1 - message buffer pointer
; DO - number of ticks before time-out
;On exit:
; DO - result code
; The status and message buffer hold completion bytes.
        CLR.W     -(SP)            ;Room for result code
        MOVE.L    AO,-(SP)         ;Status buffer
        MOVE.L    A1,-(SP)         ;Message buffer
        MOVE.L    DO,-(SP)         ;Number of ticks
        _SCSIComplete
        MOVE.W    (SP)+,DO         ;Get result code
```

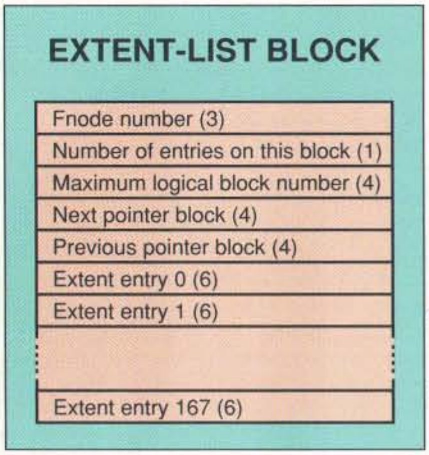
two physical sectors). This is always the first block on the partition and carries fields that define the locations and sizes of the other region. Table 1 is a layout of the partition header block.

Following the partition header are the directory and *fnode* regions. You determine the number of blocks allocated to these regions when you create the partition. These regions do not grow or shrink—they're fixed in size. Hence, the maximum number of files that can be stored on the partition is fixed at the time that the partition is created. Next comes the bit-map region. Its size is determined by the number of blocks allocated to the final area of the partition: the data region. Each bit in the bit-map region corresponds to a block in the data region. If a bit in the bit map is set to 0, the associated block is free; otherwise, the block is owned by a file.

Something Borrowed

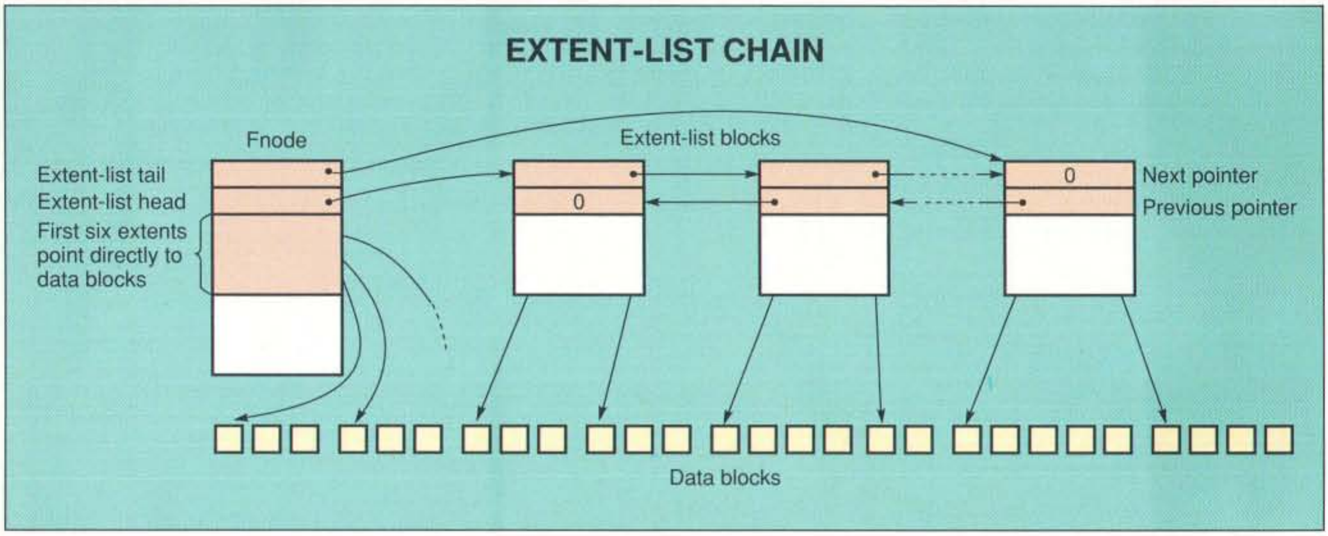
I decided to borrow structures from some file systems that I know. From Unix, I

continued



◀**Figure 4: (a)** *Each extent-list block is a member of a chain and can hold up to 168 extent entries.*

▼**(b)** *The extent-list chain is a doubly linked list of pointer blocks. Each pointer block holds up to 168 extents.*



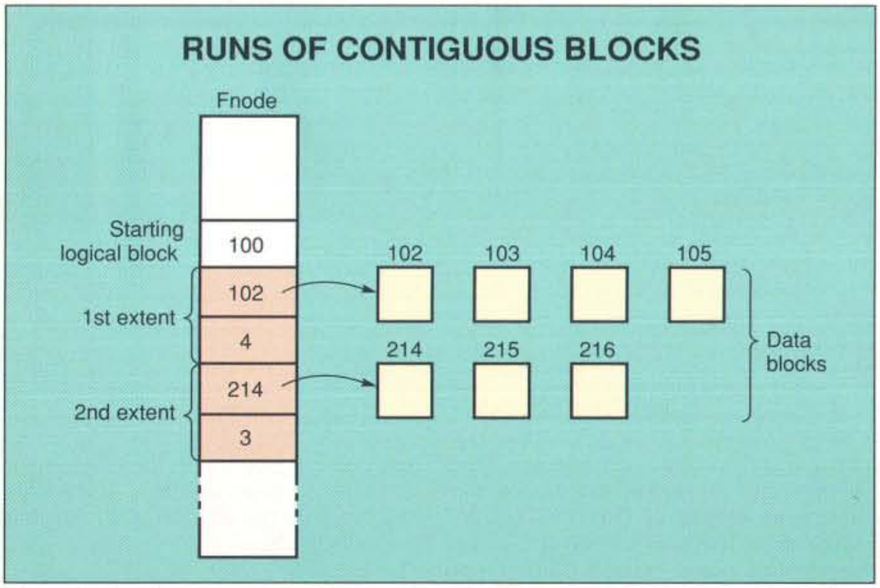
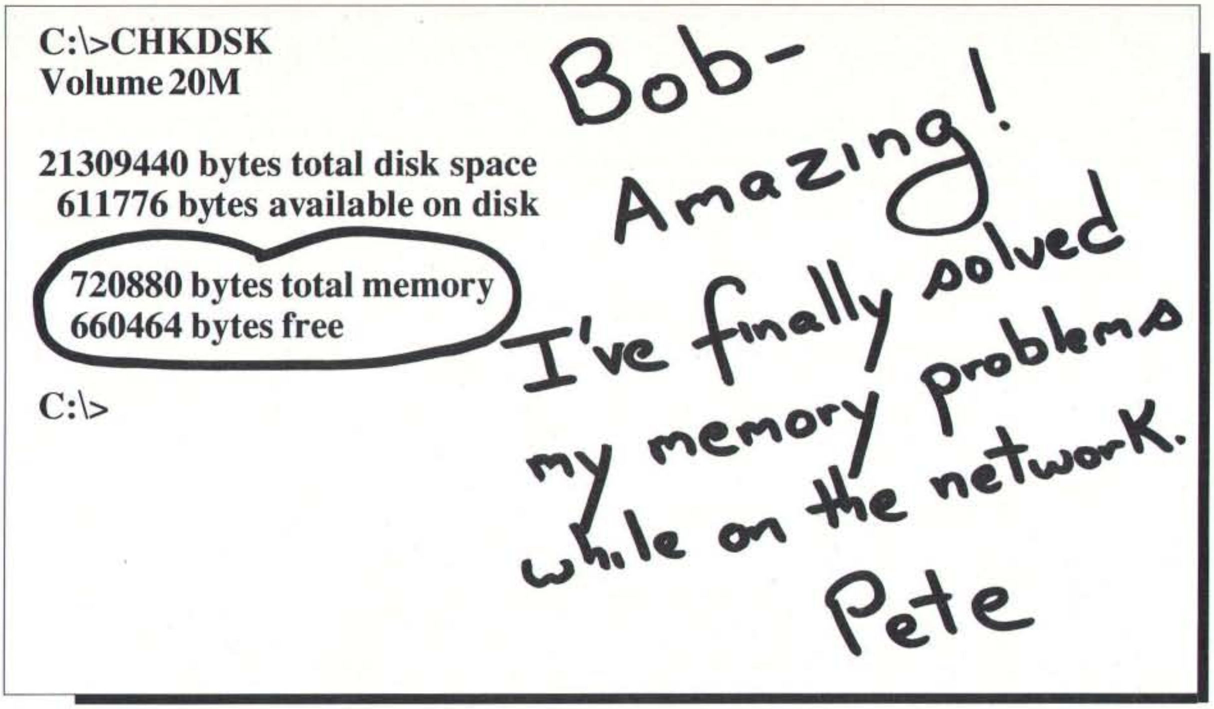


Figure 5: *Each extent entry points to a "run" of contiguous blocks. Here, logical block 100 is mapped to physical block 102, logical block 101 is mapped to physical block 103, and so on.*

borrowed the idea of keeping the structure that holds the filename apart from the structure that holds the file's storage information. Hence, the directory (see figure 2) is kept in one area while the fnode (see figure 3) is kept in another. An fnode is the portal to a file's information. (My apologies to the Unix folks for my mutation of the inode. I noticed that Microsoft's new High Performance File System [HPFS] also uses an fnode structure; I suppose the idea must be a good one.) The fnode carries information such as a file's creation and modification time, and I've added a seven-character password for the security-conscious. Most important, the fnode carries the pointers that lead to a file's data.

Each entry in a directory is preceded by a 1-byte directory area designator. Vaguely reminiscent of CP/M's user area, this lets you control access to file groups; you can create multiple directories, but there are no subdirectories. For example, a company's product inventory

continued



```
C:\>CHKDSK
Volume 20M

21309440 bytes total disk space
  611776 bytes available on disk

  720880 bytes total memory
  660464 bytes free

C:\>
```

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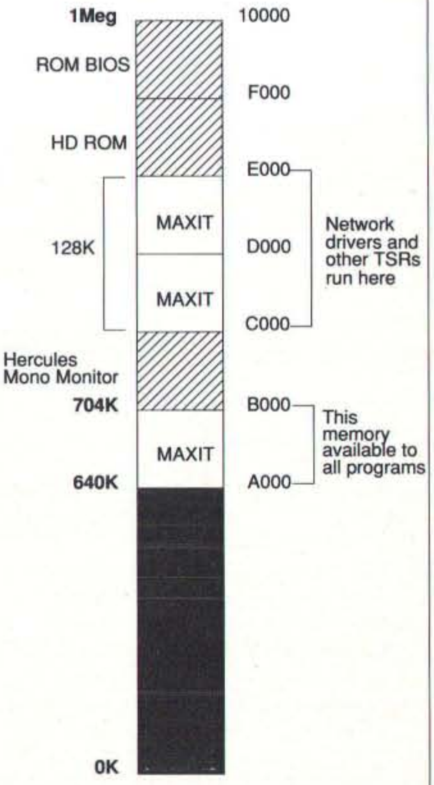

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files can be kept in one directory area accessible by employees in the stockroom, while the accounting files would reside in another directory area. (Currently, the system supports up to 50 directory areas. Access to a directory area is controlled by a password kept in the partition header block.)

Also—although I haven't implemented this in my software—since directory and fnode entries are separate, a single fnode entry could be pointed to by more than one directory entry. This would let you create "public" files. For example, users restricted to directory area 4 would be allowed access to a file originally created in directory area 3 by creating a directory entry in area 4, pointing to the file's fnode. (Of course, you'd have to modify the fnode to include a counter to keep track of the number of directory entries referencing that fnode.)

From the Macintosh, I borrowed the concept of the *extent*. The extent is the structure that any algorithm seeking to locate a file's data passes through just before its final destination. An extent points to a *run* of sequential physical blocks holding a file's data. Each extent holds two components: The first points to the starting physical block of the run, and the second holds the number of blocks in the run.

You'll notice that I've placed the first six extents in the fnode. (This is not unlike Unix's technique of placing the first 10 direct pointers in the inode.) The remaining extents are kept on a doubly linked list of pointer blocks (see figure 4), the front end of which is pointed to by the extent-list head, and the rear end of which is pointed to by the extent-list tail. This arrangement favors contiguous files, since locating an arbitrary record in the file requires fewer disk accesses if that record is contained within the first six extents. Also, if a file is large *and* highly fragmented, the system has to search along the extent-list chain to locate records.

My reasons for favoring contiguous files go back to the kind of applications I had in mind when I put this idea together. Most database applications create files that "peak out" in size after a start-up period. For example, in accounting applications, the ledger files tend to stabilize at a maximum once all the accounts have been entered. The journal entries file will grow to a peak near the end of the week, at which time the week-end postings will move the detail portion of the journal entries into the ledger file. The journal entries file is then cleared to prepare for the new week. The detail in the ledger file hits its high-water mark near the end of the month, at which time end-of-month processing collapses the detailed entries into totaling fields.

Hence, by monitoring work flow, you can usually get a good idea of the maximum number of records a given data file will have to handle throughout the year. So when you go to create the file, you simply allocate the appropriate number of blocks to the file at creation time. Given that this is a fresh partition, it is likely that the blocks would reside within the first six extents. And since the block size in my file system is 1024 bytes, and a single extent entry can reference up to 64K blocks, this means that you can define contiguous files of up to 384 megabytes (over 402 million characters) in size and still not exhaust the first six extents (see figure 5).

continued

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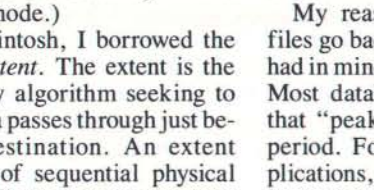

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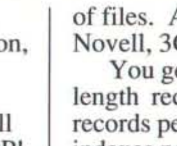

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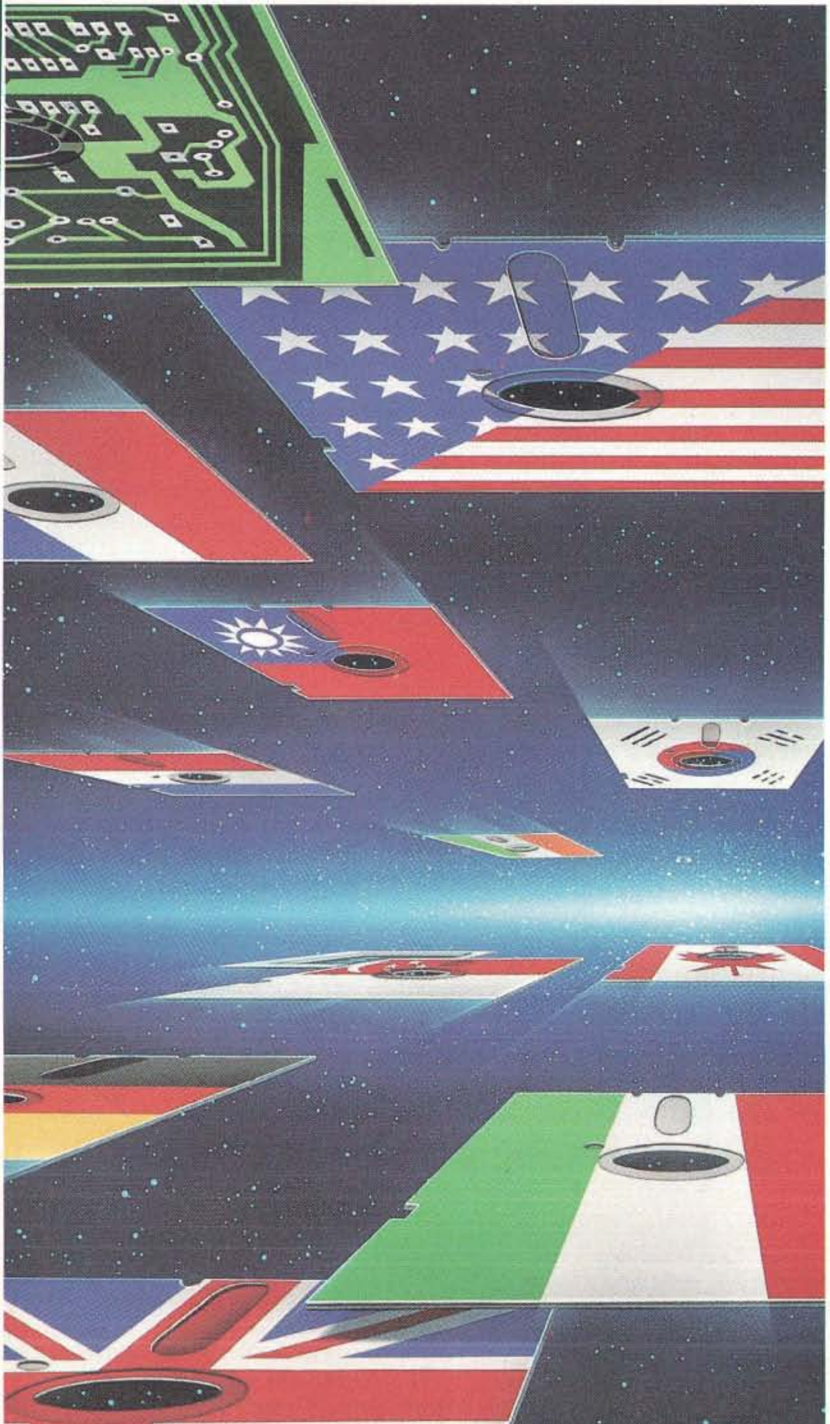

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Each extent-list block holds up to 168 extent entries. Therefore, on a totally fragmented disk, each extent-list block will reference 168K bytes' worth of data file. But if the file is created in contiguous fashion, a single extent-list block can reference up to 1.13×10^{10} bytes—more than enough, I should think.

Clumps on the Disk

In an attempt to preserve the contiguousness of a file, I have also borrowed the idea of a *clump* from the Macintosh. A clump is the minimum number of contiguous blocks that the operating system will try to give to the file whenever the file grows. (You set a file's clump size when you create it.) So, if you attempt to add one record to the file and the system sees that adding the record will require it to allocate additional blocks to the file, the file system will first try to find a clump-size run of blocks and give that to the file. Barring that, the system allocates blocks as it can.

But the upshot is that you can control the fragmentation size of the files, and files that need to be contiguous can stay reasonably close to the ideal. The downside of this technique is that if you pick a clump size that is too large, the file will tend to allocate space at the end that will go unused over most of its lifetime. I considered this a risk outweighed by the benefits of keeping sequential blocks contiguous. Plus, with disks getting bigger all the time, an unused 16K bytes here or there is probably tolerable.

Parting Partition

In the past, an alternate file system on your hard disk would have seemed not only odd, but—more important—impractical. The average size of a hard disk wasn't much more than 20 megabytes, which meant that even had you filled the disk completely with one DOS partition, there was still 12 megabytes MS-DOS *could* have been using. The situation is now reversed. A casual survey of computer mail-order houses reveals that most package PC-clone deals come with 40-megabyte hard disk drives. Disk drives of 60 and 80 megabytes are commonplace. There is room for multiple partitions; if you're running MS-DOS, it's nearly a necessity.

Although many applications will hum along nicely on file systems that are already available, many specialized situations can benefit from fine-tuning even at the level of the file. Of course, if you're a PC owner running OS/2, you can now choose the HPFS, which—since it is a completely redefined file system—solves many of the limitations of the old FAT structure. Interestingly, since they are different designs, the FAT file system and HPFS see one another as incompatible and foreign file systems. ■

Editor's note: *The source code for this month's programs is available in a variety of formats; see page 5 for details. The programs are compatible with Turbo C and should run on most PC compatibles.*

Rick Grehan is the director of the BYTE Lab. He has a B.S. in physics and applied mathematics and an M.S. in computer science/mathematics from Memphis State University. He can be reached on BIX as "rick_g."

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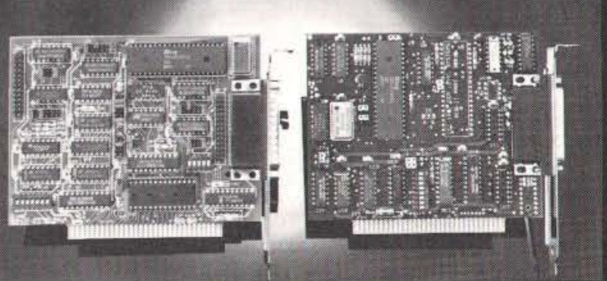

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512KIT*	IBM PS/2	100ns 256K x 9 SIMM (2 each)	99.95
2MEGKIT*	IBM PS/2	100ns 1MEG x 9 SIMM (2 each)	369.95
41256A9A-10	262,144x9	100ns 256K x 9 SIP (Has Leads)	44.95
41256A9B-80	262,144x9	80ns 256K x 9 SIMM	49.95
421000A8B-10	1,048,576x8	100ns 1MEG x 8 SIMM	109.95
421000A9A-80	1,048,576x9	80ns 1MEG x 9 SIP (Has Leads)	124.95
421000A9B-80	1,048,576x9	80ns 1MEG x 9 SIMM	119.95

*Upgrade for Models 30, 50Z and 60

7400

Part No.	1-9	10+
7400	.29	.19
7402	.29	.19
7404	.29	.19
7405	.35	.25
7406	.39	.29
7407	.39	.29
7408	.35	.25
7410	.29	.19
7411	.35	.25
7414	.49	.39
7416	.35	.25
7417	.35	.25
7420	.29	.19
7427	.29	.19
7430	.29	.19
7432	.39	.29
7438	.39	.29
7442	.49	.39
7445	.75	.65
7446	.89	.79
7447	.89	.79
7473	.39	.29
7474	.39	.29
7475	.49	.39
7476	.45	.35
7483	.59	.49
7485	.65	.55
7486	.45	.35
7489	2.25	2.15
7490	.49	.39
7493	.45	.35
7495	.59	.49
74107	.29	.19
74121	.39	.29
74123	.49	.39
74125	.49	.39
74147	1.99	1.89
74150	1.35	1.25
74151	.39	.29
74154	1.35	1.25
74161	.69	.59
74174	.59	.49
74175	.59	.49
74193	.79	.69

74LS

74LS00	.26	.16
74LS02	.28	.18
74LS03	.28	.18
74LS04	.28	.18
74LS05	.28	.18
74LS06	.59	.49
74LS07	.59	.49
74LS08	.28	.18
74LS09	.28	.18
74LS10	.26	.16
74LS11	.29	.19
74LS14	.49	.39
74LS20	.28	.18
74LS21	.29	.19
74LS27	.35	.25
74LS30	.28	.18
74LS32	.28	.18
74LS38	.35	.25
74LS42	.49	.39
74LS47	.85	.75
74LS73	.39	.29
74LS74	.35	.25
74LS75	.39	.29
74LS76	.39	.29
74LS83	.55	.45
74LS85	.55	.45
74LS86	.29	.19
74LS90	.49	.39
74LS93	.49	.39
74LS123	.49	.39
74LS125	.49	.39
74LS132	.49	.39
74LS138	.49	.39
74LS139	.49	.39
74LS151	.49	.39
74LS153	.49	.39
74LS154	1.29	1.19
74LS157	.45	.35
74LS161	.49	.39
74LS163	.49	.39
74LS164	.59	.49
74LS165	.75	.65
74LS166	.89	.79
74LS173	.45	.35
74LS174	.39	.29
74LS175	.39	.29
74LS191	.59	.49
74LS192	.69	.59
74LS193	.69	.59
74LS194	.69	.59
74LS221	.69	.59
74LS240	.59	.49
74LS241	.59	.49
74LS244	.59	.49
74LS245	.79	.69
74LS257	.49	.39
74LS259	.99	.89
74LS273	.89	.79
74LS279	.49	.39
74LS367	.49	.39
74LS373	.79	.69
74LS374	.79	.69
74LS393	.89	.79
74LS541	1.29	1.19
74LS590	5.95	5.85
74LS688	2.39	2.29

74S/PROMS*

74S00	.25
74S04	.25
74S32	.25
74S74	.25
74S112	.25
74S124	1.25
74S138	.49
74S153	.15
74S163	.75
74S174	.15
74S175	.39
74S188*	1.49
74S189	1.49
74S240	1.39
74S244	.99
74S287*	1.49
74S288*	1.49
74S373	.99
74S374	.99
74S387*	1.29
74S472*	2.95
74S571*	2.49

CD-CMOS

CD4001	.19
CD4002	.19
CD4007	.19
CD4011	.19
CD4012	.25
CD4013	.29
CD4015	.29
CD4016	.29
CD4017	.49
CD4018	.49
CD4020	.59
CD4021	.49
CD4024	.45
CD4027	.35
CD4028	.49
CD4029	.69
CD4030	.35
CD4040	.65
CD4042	.49
CD4043	.59
CD4046	.65
CD4047	.65
CD4049	.29
CD4050	.29
CD4051	.59
CD4052	.59
CD4053	.59
CD4060	.65
CD4066	.29
CD4069	.25
CD4070	.29
CD4071	.19
CD4072	.19
CD4073	.19
CD4081	.19
CD4093	.35
CD4094	.89
CD4503	.39
CD4511	.59
CD4518	.75
CD4520	.69
CD4522	.75
CD4528	.69
CD4538	.79
CD4543	.79
CD4584	.49
CD4585	.69

NEC V20 & V30 CHIPS

Replace the 8086 or 8088 in Your IBM PC and Increase its Speed by up to 30%

Part No.		Price
UPD70108-5	(5MHz) V20 Chip	5.25
UPD70108-8	(8MHz) V20 Chip	6.95
UPD70108-10	(10MHz) V20 Chip	10.95
UPD70116-8	(8MHz) V30 Chip	7.95
UPD70116-10	(10MHz) V30 Chip	13.49

MICROPROCESSOR COMPONENTS

Z80, Z80A, Z80B, SERIES

Part No.	Price
Z80	1.25
Z80A	1.29
Z80A-CTC	1.65
Z80A-DART	4.95
Z80A-PIO	1.89
Z80A-SIO/O	3.95
Z80B	2.75
Z80B-CTC	3.95
Z80B-PIO	3.95
Z8400HB1 CPU-8MHz	1.95

8000 SERIES

8031	3.95
80C31	8.95
8035	1.25
8039	1.59
8052AHBASIC	24.95
8080A	1.95
8085A	1.95
8085A-2	3.59
8086	3.95
8087 (5MHz)	89.95
8087-1 (10MHz)	169.95
8087-2 (8MHz)	129.95
8088 (5MHz)	4.95
8088-2 (8MHz)	6.95
8155	2.49

8000 SERIES Continued

Part No.	Price
8155-2	3.75
81C55	4.25
8205	9.95
82C11	6.95
8212	1.99
8216	1.39
8224	1.49
8228	1.49
8237-5	4.25
8243	1.95
8250A	4.95
8250B (For IBM)	5.95
8251A	1.95
8253	1.89
8253-5	1.95
82C53-5	3.95
8254	4.95
8255A-5	2.95
82C55A-5	4.49
8256	11.95
8259-5	2.25
8272	3.49
8274	4.75
8279-5	2.95
8282	2.95
8284A	1.95

8000 SERIES Continued

Part No.	Price
8286	2.29
8741	9.49
8742	14.95
8748 (25V)	7.95
8748H (HMOS)(21V)	9.95
8749	9.95
8751H (3.5-12MHz)	34.95
8755	13.95
80286-10 (10MHz)LCC	29.95
80287-3 (5MHz)	109.95
80287-8 (8MHz)	209.95
80287-10 (10MHz)	239.95
80386-16 PGA	249.95
80387-16 (16MHz)	349.95
80387-20 (20MHz)	399.95
80387-25 (25MHz)	499.95
82284 (8MHz)	5.49
82288 (8MHz)	6.95

DATA ACQUISITION

ADC0804LCN	3.25
ADC0808CCN	5.49
ADC0809CCN	3.75
ADC1205CCJ-1	19.95
DAC0808LCN	1.49
AY-3-1015D	4.95
AY-5-1013A	2.95

STATIC RAMS

Part No.	Function		Price
2016-12	2048x8	120ns	2.95
2102	1024x1	350ns	.89
2112	256x4	450ns MOS	2.49
2114N	1024x4	450ns	.99
2114N-2L	1024x4	200ns Low Power	1.49
21C14	1024x4	200ns (CMOS)	.49
5101	256x4	450ns (CMOS)	1.95
6116P-1	2048x8	100ns (16K) CMOS	3.19
6116P-3	2048x8	150ns (16K) CMOS	2.79
6116LP-1	2048x8	100ns (16K) LP CMOS	3.59
6116LP-3	2048x8	150ns (16K) LP CMOS	3.09
6264P-10	8192x8	100ns (64K) CMOS	6.75
6264P-15	8192x8	150ns (64K) CMOS	4.95
6264LP-10	8192x8	100ns (64K) LP CMOS	6.95
6264LP-12	8192x8	120ns (64K) LP CMOS	6.49
6264LP-15	8192x8	150ns (64K) LP CMOS	4.95
6514	1024x4	350ns CMOS	3.25
43256-10L	32,768x8	100ns (256K) Low Power	10.95
43256-15L	32,768x8	150ns (256K) Low Power	9.95
62256LP-10	32,768x8	100ns (256K) LP CMOS	11.95
62256LP-12	32,768x8	120ns (256K) LP CMOS	11.25
62256LP-15	32,768x8	150ns (256K) LP CMOS	10.95

DYNAMIC RAMS

TMS4416-12	16,384x4	120ns	3.95
TMS4416-15	16,384x4	150ns	3.75
4116-15	16,384x1	150ns (MM5290N-2)	1.09
4128-15	131,072x1	150ns (Piggyback)	4.49
4164-100	65,536x1	100ns	2.75
4164-120	65,536x1	120ns	2.39
4164-150	65,536x1	150ns	2.15
41256-60	262,144x1	60ns	5.25
41256-80	262,144x1	80ns	3.75
41256-100	262,144x1	100ns	3.15
41256-120	262,144x1	120ns	2.95
41256-150	262,144x1	150ns	2.59
41264-12	64Kx4	120ns Video RAM	10.95
41464-80	65,536x4	80ns	5.95
41464-12	65,536x4	120ns	3.95
41464-15	65,536x4	150ns	3.59
51258-10	262,144x1	100ns Static Column	8.95
511000P-80	1,048,576x1	80ns (1 Meg)	12.95
511000P-10	1,048,576x1	100ns (1 Meg)	12.35
514256P-10	262,144x4	100ns (1 Meg)	12.95
514258-10	262,144x4	100ns Static Column	26.95

EPROMS

TMS2516	2048x8	450ns (25V)	4.95
TMS2532	4096x8	450ns (25V)	5.95
TMS2532A	4096x8	450ns (12.5V)	5.25
TMS2564	8192x8	450ns (25V)	6.95
TMS2716	2048x8	450ns (-5V, +5V, +12V)	6.49
1702A	256x8	2K (1µs)	4.25
2708	1024x8	450ns	6.95
2716	2048x8	450ns (25V)	3.49
2716-1	2048x8	350ns (25V)	3.95
27C16	2048x8	450ns (25V) CMOS	4.25
2732	4096x8	450ns (25V)	3.95
2732A-20	4096x8	200ns (21V)	3.95
27C32	4096x8	450ns (25V) CMOS	4.25
2764-25	8192x8	250ns (21V)	3.95
2764A-20	8192x8	200ns (12.5V)	4.19
2764A-25	8192x8	250ns (12.5V)	3.49
27C64-15	8192x8	150ns (12.5V) CMOS	4.95
27128-20	16,384x8	200ns (21V)	5.95
27128-25	16,384x8	250ns (21V)	5.25
27128A-15	16,384x8	150ns (12.5V)	6.95
27128A-20	16,384x8	200ns (12.5V)	4.75
27C128-25	16,384x8	250ns (21V) CMOS	5.95
27256-15	32,768x8	150ns (12.5V)	8.49
27256-20	32,768x8	200ns (12.5V)	5.49
27256-25	32,768x8	250ns (12.5V)	4.95
27C256-15	32,768x8	150ns (12.5V) CMOS	7.25
27C256-25	32,768x8	250ns (12.5V) CMOS	5.49
27512-25	65,536x8	250ns (12.5V)	7.25
27C512-15	65,536x8	150ns (12.5V) CMOS	9.95
27C512-25	65,536x8	250ns (12.5V) CMOS	7.49
27C010-15	131,072x8	150ns (12.5V) CMOS (1 Meg)	19.95
68764	8192x8	64K 450ns (25V) (Chip Enable)	14.95
68766-35	8192x8	64K 350ns (25V) (Output Enable)	15.95

EEPROMS

2816A-25	2048x8 250ns (9V-15V) 5V **Read/Write**	5.49
2817A	2048x8 350ns 5V **Read/Write**	6.95
2864A	8192x8 250ns 5V **Read/Write** (Pin 1, No R/B)	10.95
2865A	8192x8 250ns 5V **Read/Write**	10.95

6500/6800 68000 Series

Part No.	Price
6402	3.75
6502	2.19
6502A	2.59
65C02 (CMOS)	6.95
6520	1.59
6522	2.95
65C22	4.25
6532	4.95
6551	2.69
65C802 (CMOS)	15.95
6800	1.75
6802	2.95
6808	2.49
6810	1.25
6820	2.75
6821	1.75
68B21	2.25
6840	3.49
6845	2.75
6850	1.75
6852	.49
MC68000L8	9.95
MC68000L10	11.95
MC68008P8	4.95
MC68010L10	19.95
MC68020RC12B	44.95
MC68450L10	14.95
MC68701	19.95
MC68705P3S	15.95
MC68705U3S	17.95
MC68881RC16A	129.95
MC68881RC20A	139.95

Commodore

WD1770	8.95
SI3052P	.49
6504A	.75
6510	14.95
6526	13.95
6526A	14.95
6545-1	3.95
6560	6.95
6567	24.95
6572	2.95
6581 (12V)	12.95
8502	7.95
8564	2.95
8566	4.95
8701	9.95
8722	4.95
*82S100PLA**	15.95
310654-05	9.95
325572-01	17.95
901225-01	15.95
901226-01	15.95
901227-02	4.95
901227-03	15.95
901229-05	15.95
901460-03	.99
901486-06	1.49

*No specs available

**Note: 82S100PLA = U17 (C-64)

74C/CMOS

74C00	.25
74C02	.25
74C04	.25
74C08	.25
74C10	.19
74C14	.49
74C32	.45
74C74	.49
74C85	1.29
74C86	.29
74C89	1.49
74C90	.99
74C151	.99
74C154	2.95
74C157	1.49
74C160	.25
74C161	.25
74C162	.25
74C173	.25
74C174	.39
74C175	.39
74C192	.99
74C194	.25
74C221	1.79
74C240	.49
74C244	1.49
74C373	1.49
74C374	1.49
74C911	5.95
74C912	7.95
74C915	.69
74C917	3.95
74C920	3.95
74C921	2.49
74C922	3.95
74C923	3.95
74C925	4.95
74C926	5.95

MISC. COMPONENTS

TANTALUM CAPACITORS

TM.1	.1µf @ 35V	.19
TM1	1µf @ 35V	.19
TM2.2	2.2µf @ 35V	.25
TM4.7	4.7µf @ 35V	.45
TM6.8	6.8µf @ 35V	.59
TM10	10µf @ 35V	.69

POTENTIOMETERS

Values available (insert ohms into space marked "XX"): 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 500K, 1MEG

43PXX	3/4 Watt,15Turn	**.99**
63PXX	1/2 Watt, 1Turn	**.89**

TRANSISTORS AND DIODES

PN2222	.13
2N2222A	.29
2N3055	.69
2N3904	.12
PN2907	.13
2N4401	.15
1N270	.25
1N751	.15
1N4004	.10
1N4148	.07
1N4735	.25
C106B1	.49

SWITCHES

JMT123	SPDT, On-On	1.25
MPC121	SPDT, On-Off-On	1.25
206-8	SPST, 16-pin DIP	1.19
MS102	SPST, Momentary	.39

D-SUB CONNECTORS

DB25P	Male, 25-pin	.69
DB25S	Female, 25-pin	.75

LEDS

XC209R T1, Red	.15
XC556R T1¾, Red	.13
XC556G T1¾, Green	.17
XC556Y T1¾, Yellow	.17

IC SOCKETS

Low Profile		Wire Wrap (Gold) Level #2	
8LP	.11	8WW	.49
14LP	.12	14WW	.65
16LP	.13	16WW	.69
24LP	.21	24WW	1.19
28LP	.23	28WW	1.39
40LP	.29	40WW	1.89

Soldertail Standard (Gold & Tin) & Header Plug Sockets Also Available

74HC HI-SPEED CMOS

Part No.	Price
74HC00	.19
74HC02	.19
74HC04	.19
74HC08	.19
74HC10	.19
74HC14	.29
74HC30	.25
74HC32	.25
74HC74	.29
74HC75	.35
74HC76	.35
74HC85	.55
74HC86	.29
74HC123	.59
74HC125	.49
74HC132	.49
74HC138	.45
74HC139	.39
74HC154	1.49
74HC163	.39
74HC174	.59
74HC175	.59
74HC221	.89
74HC240	.69
74HC244	.79
74HC245	.79
74HC253	.49
74HC259	.49
74HC273	.49
74HC373	.69
74HC374	.69
74HC595	1.29
74HC688	1.49
74HC943	6.95
74HC4040	.79
74HC4049	.19
74HC4050	.25
74HC4060	.69
74HC4511	.49
74HC4514	1.79
74HC4538	1.19
74HC4543	1.19

74HCT-CMOS TTL

74HCT00	.17
74HCT02	.17
74HCT04	.19
74HCT08	.17
74HCT14	.29
74HCT32	.19
74HCT74	.29
74HCT86	.25
74HCT138	.39
74HCT139	.39
74HCT157	.29
74HCT174	.15
74HCT175	.19
74HCT240	.69
74HCT244	.49
74HCT245	.49
74HCT373	.49
74HCT374	.39

LINEAR

Part No.	1-9	10+
TL071CP	.69	.59
TL072CP	.79	.69
TL074CN	.99	.89
TL081CP	.59	.49
TL082CP	.59	.49
TL084CN	.99	.89
LM307N	.45	.39
LM308N	.65	.59
LM309K	1.49	1.25
LM310N	1.49	1.25
LM311N	.49	.39
LM317T	.69	.59
LM318N	1.09	.99
LM319N	1.29	1.19
LM323K	3.49	3.25
LM324N	.39	.35
LM335Z	1.49	1.25
LM336Z	1.09	.99
LM337T	1.29	1.09
LM338K	4.49	4.25
LM339N	.49	.39
LF347N	1.49	1.25
LM348N	.69	.59
LF351N	.49	.39
LF353N	.59	.49
LF356N	.89	.79
LF357N	.99	.89
LM358N	.59	.49
LM380N	.89	.79
LM385Z1.2	1.75	1.49
LM386N-3	.89	.79
LM393N	.45	.39
LF398N	1.95	1.75
LF411CN	.79	.69
LF412CN	1.29	1.19
NE555V	.35	.29
XRL555	.75	.65
LM556N	.49	.39
LM565N	.99	.89
LM566CN	1.29	1.19
LM567V	.75	.65
LM723CN	.49	.39
LM741CN	.35	.29
LM747CN	.59	.49
LM1458N	.39	.35
LM1488N	.49	.45
DS14C88N	1.19	1.09
LM1489N	.49	.45
DS14C89N	1.19	1.09
LM1496N	.69	.59
LM1871N	1.95	1.75
LM1872N	1.95	1.75
ULN2003A	.79	.69
ULN2004A	.79	.69
26LS29	2.95	2.75
26LS31	1.19	.99
26LS32	1.19	.99
26LS33	1.75	1.49
ULN2803A	1.19	.99
LM2901N	.39	.29
LM2907N	1.29	1.19
LM2917N (8 pin)	1.75	1.49
MC3470P	1.29	1.19
MC3479P	3.95	3.75
MC3486P	1.29	1.19
MC3487P	1.29	1.19
LM3900N	.49	.45
LM3905N	1.29	1.19
LM3909N	.89	.79
LM3914N	1.95	1.75
NE5532	.89	.79
NE5534	.89	.79
7805K	1.29	1.19
7812K	1.29	1.19
7815K	1.29	1.19
7805T	.49	.45
7808T	.49	.45
7812T	.49	.45
7815T	.49	.45
7905K	1.49	1.25
7905T	.55	.49
75113	1.39	1.19
75150	1.29	1.19
75154	1.29	1.19
75174	2.95	2.75
75175	2.95	2.75
75176	2.25	1.95
75451	.45	.39
75452	.45	.39
75492	.89	.79
MC145406P	2.95	2.75

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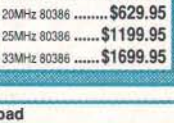

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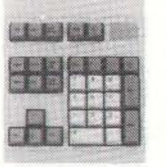

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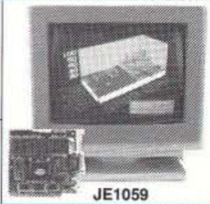

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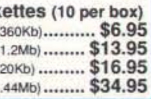

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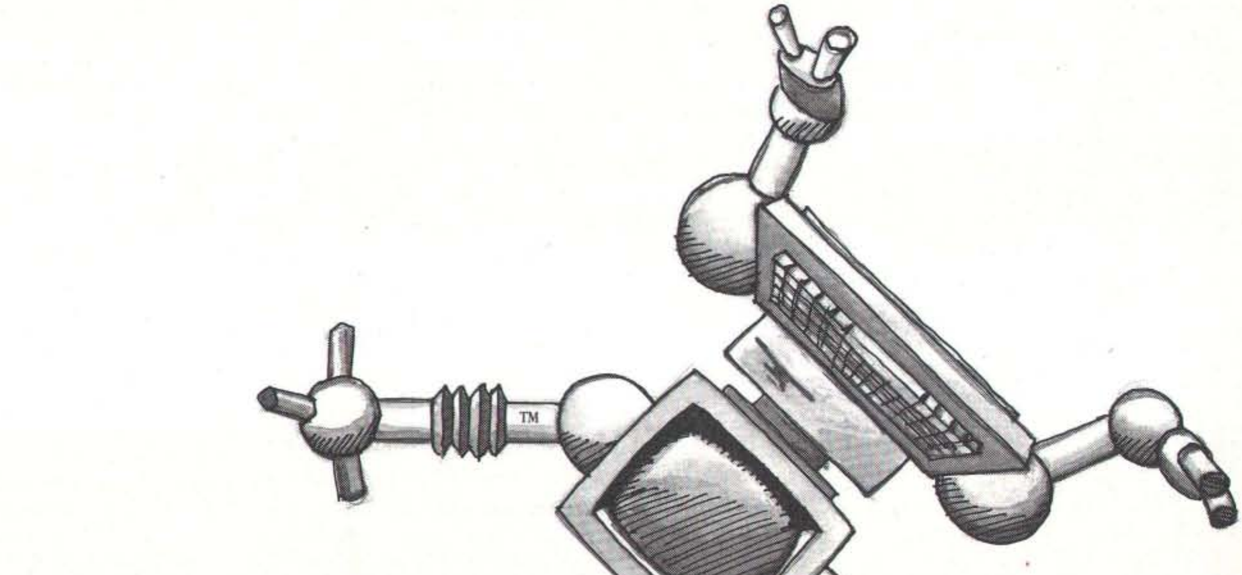

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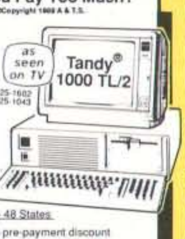

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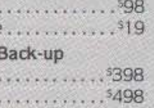

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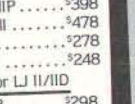

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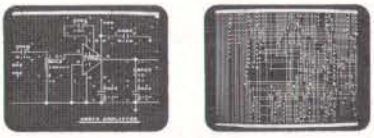

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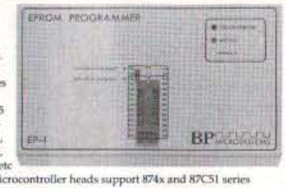

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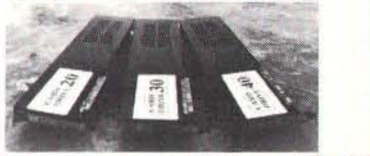

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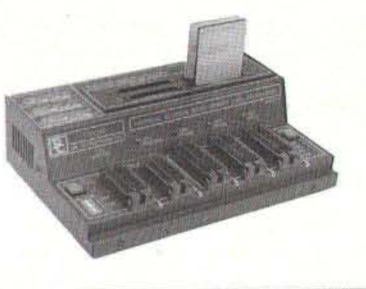

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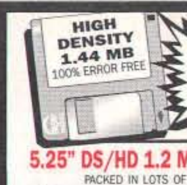

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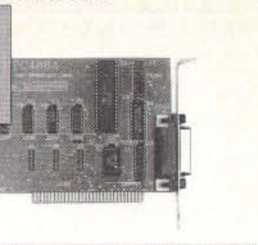

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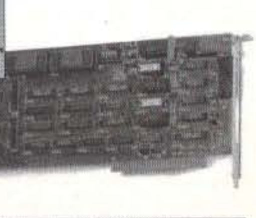

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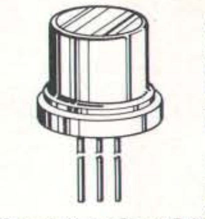

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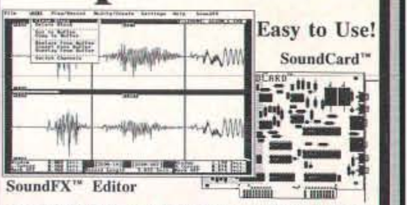

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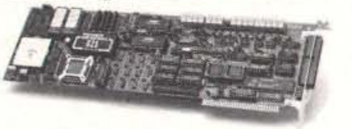

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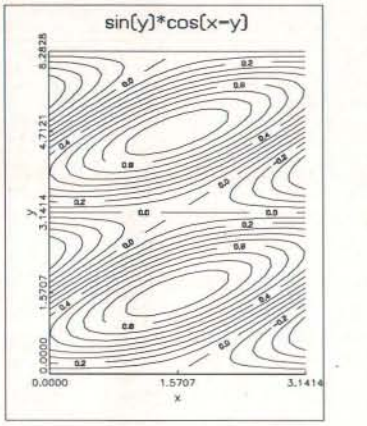

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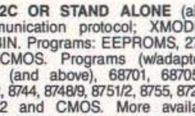

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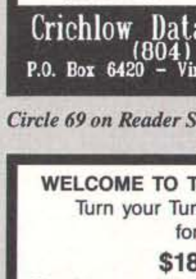

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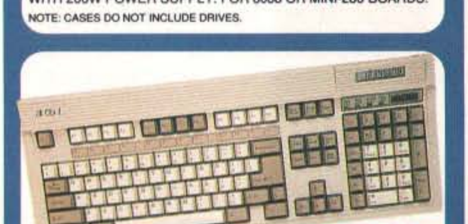

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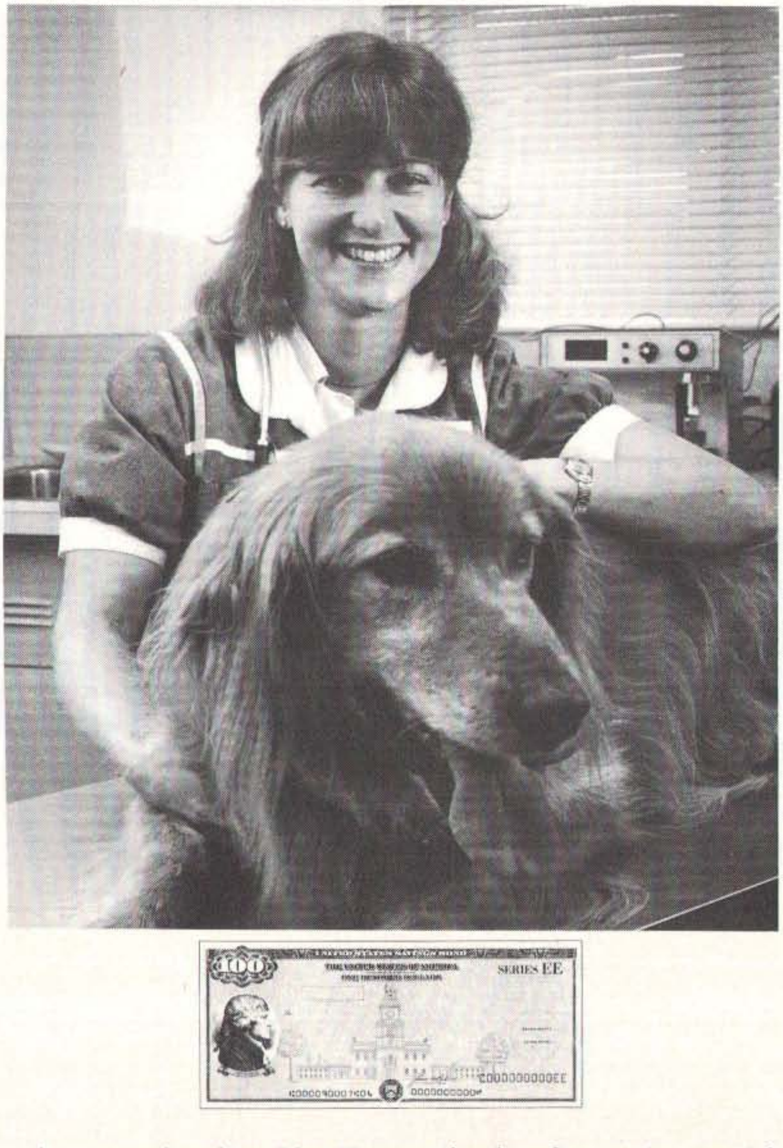

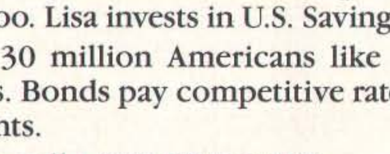

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

Furl/Fort, Continued

Dear Jerry,

Although most of your readers probably are not using the speed of light in furlongs per fortnight (furl/fort) in their day-to-day calculations, I believe that it is important to comment on William Matheson's letter (July 1989) concerning the appropriate number of significant digits.

CODATA (the Committee on Data for Science and Technology of the International Council of Scientific Unions) has defined the speed of light, c, as exactly 299,792,458 meters per second. Thus, the precision of c is not limited by the number of digits specified in the definition, and the value can be stated properly to any number of digits. Given that the conversion factors 2.54 centimeters/inch (SI units), 12 inches/foot, 660 feet/furlong, 86,400 seconds/mean solar day, and 14 mean solar days/fortnight are also exact by definition, the speed of light in furl/fort is also an exact number, expressible to any number of digits desired, using appropriate round-off rules. To 74 digits, c = 1.8,026,174,997,852,541,-159,627,773,801,002,147,458,840,-372,226,198,997,852,541,156,220,-970,935,808 $\times 10^{12}$ furl/fort. Although the uncertainty has been arbitrarily eliminated for the speed of light, it still exists in the measurement of time (the second) and in the dependent measurement of length (the meter).

I should point out that relying on significant digits to determine the range of uncertainty of any number is potentially deceptive. Even if any of the numbers above were defined as significant numbers, the result of any computation with a significant number is not a significant number. As D. B. De Lury pointed out in a thoroughly enjoyable paper ("Computations with Approximate Numbers," *Physics Today*, August 1989), "People who take their computations seriously do not use significant numbers, nor do they necessarily state the results as significant numbers."

Richard Strickert
Austin, TX

I doubt that this particular discussion will ever *end. It's great fun, though.*
—Jerry

Wanted: DOS Utility

Dear Jerry,

I would appreciate your advice on a DOS utility that I need and cannot find. I need a .BAT file for DOS 3.3 that will let me install a RAM drive in extended memory after booting up.

Here's the story. Using a 20-MHz 80386/80387 machine with 4 megabytes of RAM and running DOS 3.3, I review engineering and scientific software. I look at four flavors of DOS software: those that ignore extended memory (e.g., StatGraphics), the most common type; those needing one or two RAM drives (e.g., the Microsoft C and FORTRAN compilers); those written with the Phar Lap tools and that make direct use of extended memory as main memory (e.g., Mathematica and APL*Plus II/386); and, finally, those that require expanded memory (e.g., Excel and MathCAD).

I would like to be able to boot the machine from the C drive with neither EMS nor RAM drives installed and then use .BAT files to set up what I need. There could be three options: Do nothing, set up one or two RAM drives, or set up expanded memory.

At present, I have to set up these various environments with separate boot floppy disks. That practice deprives me of the use of drive A throughout the session. The installation of the EMS environment, when required, is no problem using Quarterdeck's QEMM 386. But I can't find a way to launch the RAM drives after boot-up; they want to be planted at the boot. Very inconvenient.

Can you give me a reference to a DOS utility that could knock this problem?

Norm C. Peterson
Santa Monica, CA

continued

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Circle 121 on Reader Service Card

I'm not aware of such a program, but if it exists, one of my readers will know. Incidentally, the fastest way to find out things like that is to ask on BIX. You'll often get an answer in hours.—Jerry

Sherlock Holmes on Disk

Dear Jerry,

Your column about CD-ROMs (September 1989) mentioned the availability of the complete text of the 60 Sherlock Holmes stories, both on floppy disks and on CD-ROM. Although you gave your readers a source for the CD-ROM version, I thought that some of them might be interested in knowing where they can purchase the floppy disk–based set as well.

The MS-DOS version (15 5¼-inch or eight 3½-inch disks), called An Electronic Holmes Companion, is available for $59.95 plus $3 shipping from Psy-Logic Systems (P.O. Box 315, Tolland, CT 06084). A six-disk version for the Macintosh, The Macintosh Holmes Companion, is available for the same price from Baker Street Software (P.O. Box 2712, Santa Clara, CA 95055).

The text, which was scanned through a Palantir (now Calera Systems) Compound Document Processor optical-character-recognition scanner, is identical for all three products. However, the supporting software does differ from version to version.

Robert J. Stek
Tolland, CT

Thanks, and apologies; I thought I had mentioned it in the column.—Jerry ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. He can be reached c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "jerryp."

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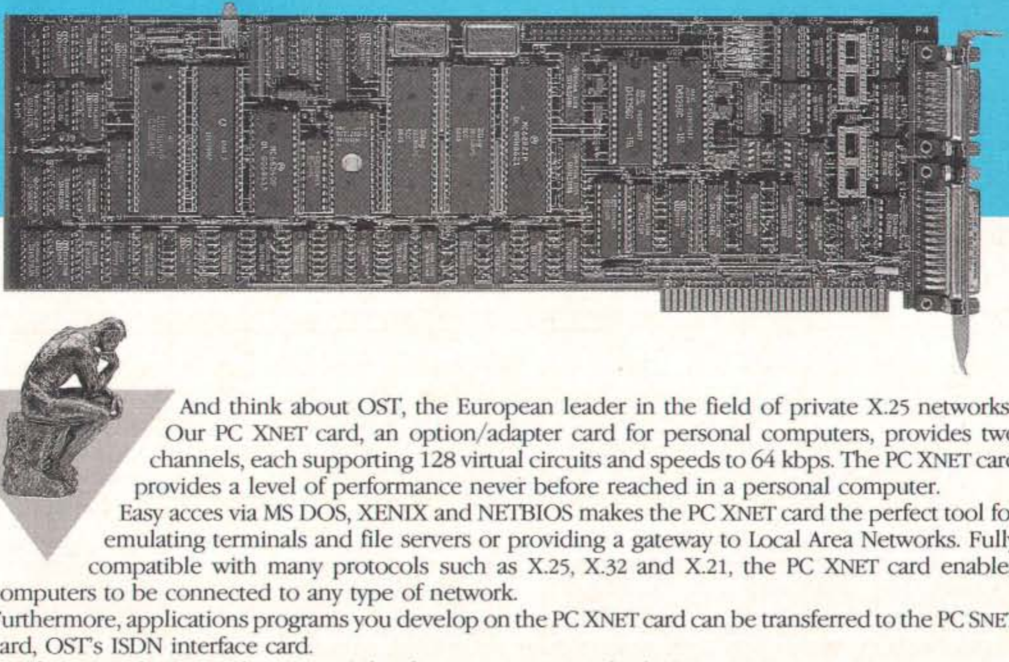

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PRINT QUEUE

Hugh Kenner

Our Man in Berkeley

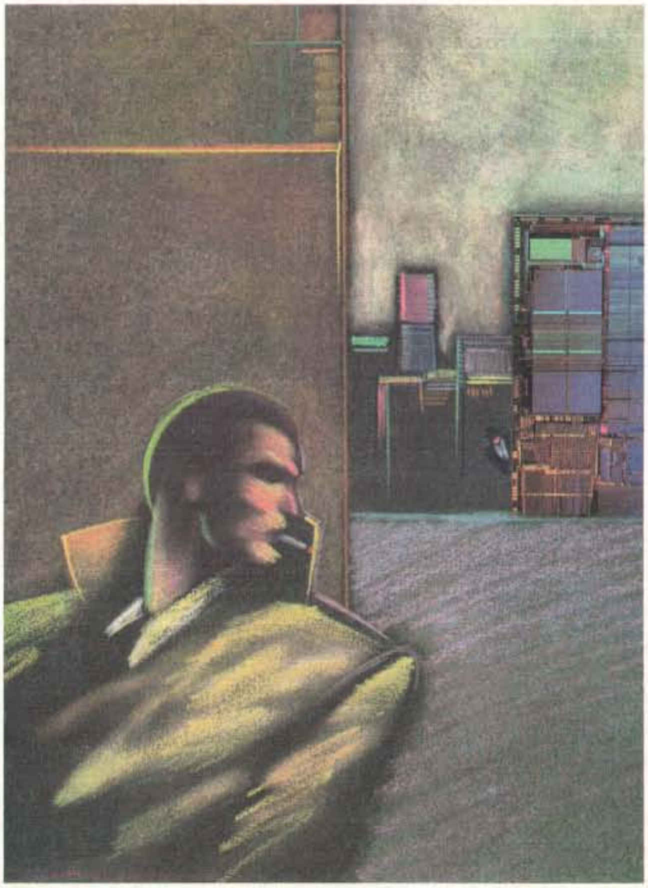
Against a background of bureaucratic apathy, a heroic hacker tracks down an international computer spy

Finally, a computer book guaranteed to keep you up late turning pages. No, not the *68030 Assembly Language Reference* today's mail brought me. What has left me agog is Clifford Stoll's *The Cuckoo's Egg: Tracking a Spy Through the Maze of Computer Espionage* (1989, Doubleday, New York, $19.95).

The Cuckoo's Egg is Stoll's account of the year he spent tracking a computer spy, against such obstacles as these: no funding to speak of; cold shoulders at the CIA, the FBI, the military—just about every outfit that should have been interested; a boss who kept blowing his stack about wasted time; a girlfriend, Martha, who'd pout as often as Stoll's beeper interfered with romance ("He's logging on again!"); a background in astronomy, not in computing, and certainly not in counterespionage; a jeans-and-sneakers mind-set that kept him asking what he was doing anyway, playing the game of the buttoned-down establishment.

In fairness to the buttoned-down, I ought to report that Stoll in person—anyway, on TV, where Connie Chung chatted with him last December—can seem hard to take seriously. Central Casting's classic nerd, fidgeting, grinning, grimacing, in utter indifference to appalling clutter: Even cool Connie could barely conceal her amusement. Had she wandered into an outtake from *Animal House*? But when printed pages screen such mannerisms, we gain access to an exceptional mind. One thing is sure: Clifford Stoll is a born writer.

Not a paragraph is wasted. What seems at first like self-indulgent reverie—the interluding with Martha—comes cycling up through the narrative when, as late as page 208, it's Martha, while sharing a shower, who dreams up Operation Showerhead, the crucial break in the case. (A smart woman indeed. She's now Mrs. Stoll. And our classic hippie had thought he'd never do so bourgeois a thing as marry!)



Oh—speaking of domesticity, ignore the cookie recipe on page 126. It's grotesquely unhealthy. Apart from that, savor every page.

In the best Len Deighton tradition, it all starts in August 1986 with a shortfall of 75 cents in a month's total of $2387. At the Lawrence Berkeley Lab, a few seconds' machine time had gone unpaid for. It seemed worth tracking down only because it might point to a bug in the accounting software. What it pointed to was a new user who'd not been properly installed. But no one at Berkeley had installed him. And his brief sojourn had coincided with an attempt, from Berkeley, to break into a system in Maryland.

That 75 cents thereafter haunts the narrative. A main reason the FBI would refuse to get interested was disdain for damages lower than half a million. Six bits? A federal case? You can hear the snickers. Even when it could be demonstrated that Mr. Baddie was rifling the files of military computers, the FBI had its mind fixed on 75 cents.

The cuckoo lays its eggs for other birds to hatch, and the cuckoo's egg of Stoll's title is laid by the intruder, in distant systems, to earn himself superuser privileges. A Unix superuser can go anywhere, poke into anything. To lay the egg, he needs to at least log on, and our man achieved that far too often for comfort. A profile slowly emerges. He is patient, thorough, textbook-Germanic. (Likely, too, a chain-smoker; passwords he favors include Benson and Hedges.) He's not fluent in the Berkeley dialect of Unix. But he's aware that systems get shipped with factory account names and passwords the buyers are admonished to alter but often don't. "Field" and "Service" are two common ones on a VAX.

And, once logged on, suppose he finds a long list of

continued

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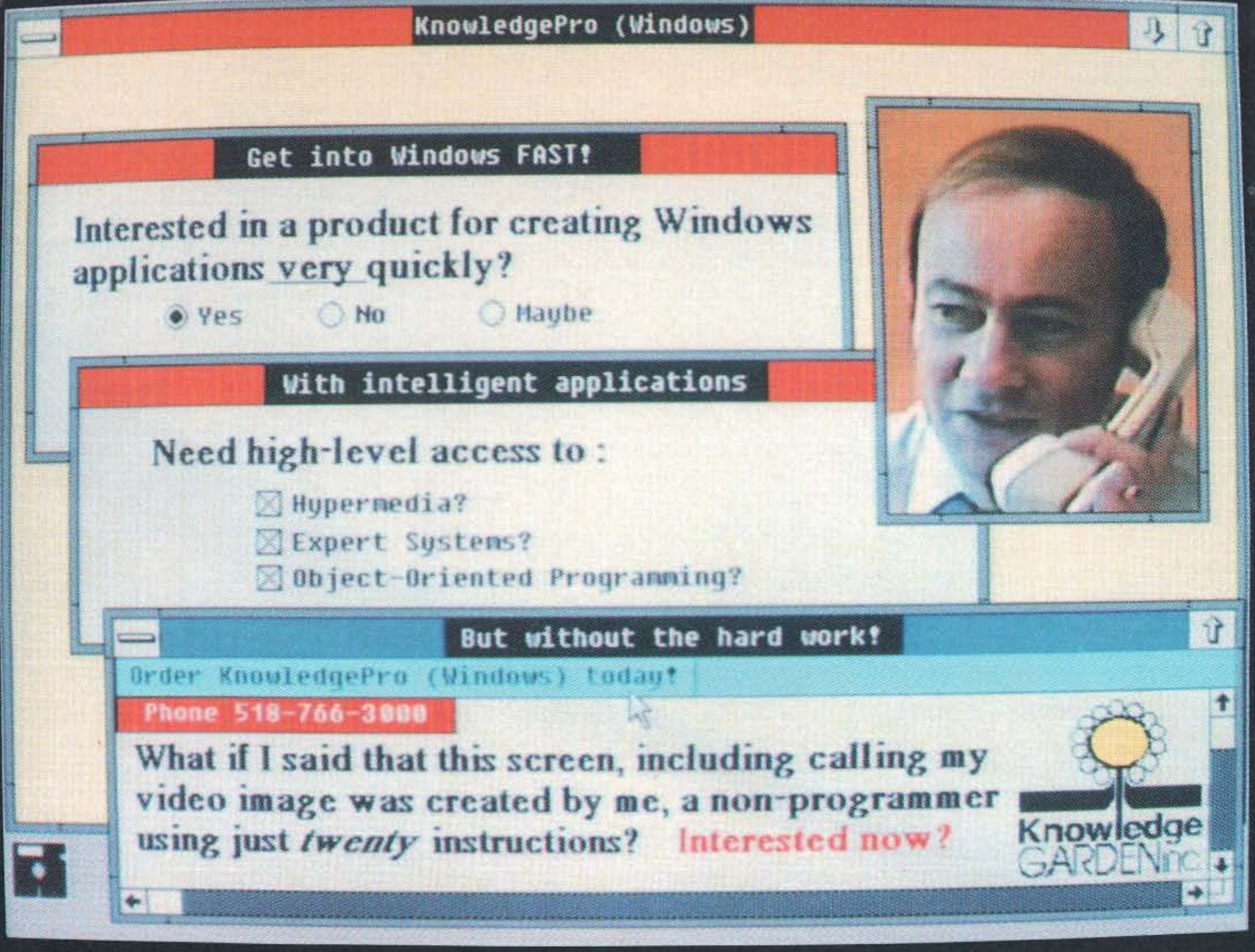

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encrypted passwords? Encrypted by a trapdoor algorithm that isn't reversible? No problem. He downloads the list and then has a program use the (public) algorithm to encrypt every word in the dictionary till it finds a match. Careless folk use dictionary words, instead of words like *fumblefoot*, for passwords. Systems we taxpayers underwrite seem to abound in fumble-footed carelessfolk.

Thus, there was the time he got onto Air Force Systems Command, Space Division. (A third try got him on, with user name "Field," password "Service." Good old VAX.) He saw a warning that his password had expired, complete with instructions for updating it. Euphoria made him disregard that instruction; "Service"—a lucky guess—was letting him read, write, even erase, absolutely anything. Euphoric, he stayed on, downloading files, for 2 hours. But later ("Password Expired") he couldn't get back on.

> *The system in Hannover isn't computerized. To trace a call there, a man on the premises must search through miles of wire. He'll need an hour.*

Yet, once again, no problem. A few days afterward, they'd reenabled "Field" with the same old password. "The service technician," Stoll writes, "may have noticed that the account had expired, and asked the system manager to reset the password." As the system manager did. Without a moment's thought. (Why think up a new password?) So here's our man, back again, again using "Service," which works as it did before; for that matter, as when that VAX left the factory.

And no one seems to be following all this save Cliff Stoll. At Berkeley, where he's meant to be doing astronomy, he keeps, on old printers that can jam, a tireless log—piles of printout—of every time our man uses the Berkeley system to effect entry to the U.S. One day, a jammed printer loses maybe 20 minutes of illicit activity. My one question, since Stoll does mention floppy disks, which of course have limited capacity, is whether or why Lawrence-at-Berkeley didn't boast such a thing as a good-size hard disk drive.

Anyway, Stoll's beeper sounds for each unauthorized entry. (Martha moans as he dashes off on his bike.) The CIA won't give Stoll the time of day. The FBI's attitude we've noted. Forget NSA, OSI, DOE, even FCI. ("Federal Cat Inspector?" Stoll did wonder. It turned out to mean "Foreign Counter-Intelligence.") For months, his sole link to sanity was a man named Steve.

Steve White, an Englishman based in Vienna, Virginia, works for Tymnet, seeing that its links stay flawless. "To him, the network is a gossamer web of connections: invisible threads that appear and disappear every few seconds. Each of his three thousand nodes have to be able to instantly talk to each other." If you saw two kludges in that last sentence, you see why I wish Doubleday did better copy editing. And if your eyes lit up at the mention of Tymnet, chances are you subscribe to BIX or some other service that uses Tymnet's skill at linking anything instantly to anything via threads of addresses.

By now we've worked out that our man is in Germany. His link to the U.S. is the Tymnet International Gateway. His link to Stoll's computer is domestic Tymnet. His link to some 400 Milnet (military) computers is normally via Stoll. He doesn't know Stoll is listening. Nor does he know about Steve White.

A beep tells Stoll our man is logging on. Stoll's instant reflex is a call to Steve. And, so expert is Steve, he's soon tracing those calls in under a minute, all the way back to (usually) Hannover, West Germany. German telecommunications are state-run. Soon Steve has established contact with a Bundespost sleuth named Wolfgang Hoffman. For Hoffman—at last for someone!—the game was afoot. But he needed an order from the FBI. The FBI . . . well, there are space limits on this review.

Briefly: You can trace a call quickly in a computerized telephone system. But the system in Hannover isn't computerized. To trace a call there, a man on the premises must search through miles of wire. He'll need an hour. Also, since our felon makes his calls at night—low transatlantic rates—Hoffman's man will need to be in the building after closing time. Overtime, you see. That will all take some bureaucratic nudging.

Well, the FBI wasn't interested (75 cents!), nor was the CIA, nor any of the rest. That was where Operation Showerhead came in. The first thing was to keep our man on for an hour—a man who'd been logging on and off in minutes. But—forget all those agencies—we don't need anyone's permission to put stuff into our own computer. So why not stuff it full of military secrets (pseudo)? And trust our man to bite?

As they did. They stuffed Stoll's machine full of SDINET, which looked like a top-secret Berkeley contract and was actually genuine military gobbledygook spiced with just enough pseudodata to look sexy. They even invented a typist named Barbara Sherwin, charmingly inept as she fumbled with her new word processor to upload new stuff every few days but occasionally taking a day off when Stoll couldn't stand any more. She even left a form letter about how you could get more information by sending your name and address to the project office.

Our man bit. His name turned out to be Markus Hess. The chap who looked over his shoulder and fed findings to the KGB was supporting a cocaine habit. No, nothing political. Just cash for cocaine. What the KGB's been making of SDINET is another question. This book will be prompting a ferocious assault on (doubtless computerized) files.

Hess is out on bail, still smoking Benson & Hedges, still awaiting trial. The charred bones of his sponsor were found last May 23, next to a melted can of gasoline. No suicide note, although the suspicious may discern KGB fingerprints.

The Stolls are in Cambridge, Massachusetts, now. That's a long way from Berkeley. He lectures on computer security (who better qualified?) and writes astrophysics software. They live with "two cats which he pretends to dislike." ■

Hugh Kenner is a professor of English at Johns Hopkins University. His reviews have appeared in publications like the New York Times *and* Harper's. *His recent books include* A Sinking Island *and* Mazes. *He can be contacted on BIX as "hkenner."*

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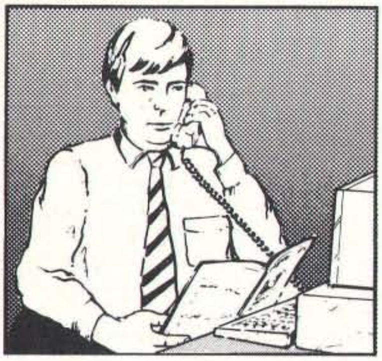

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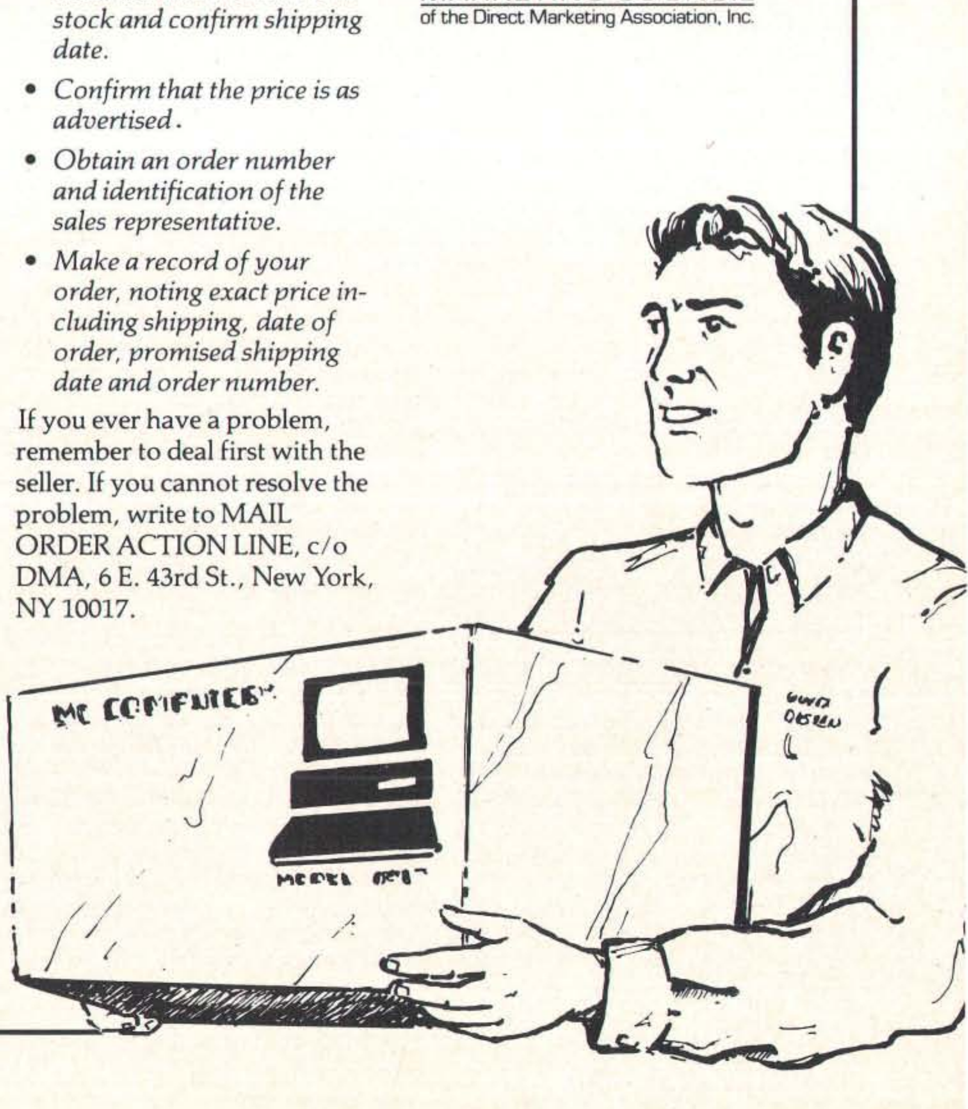

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STOP BIT ■ Jonathan Grudin

A FOOLISH CONSISTENCY

Let's make users' work easier, not just more consistent

In the beginning, a few lone voices called out for "consistent user interfaces." Today, that cry has become a deafening chorus, one of few points of agreement among user interface designers.

Encouraged by the success of the Macintosh interface, other companies are adopting a consistent look and feel; observe IBM's major investment in Microsoft Windows, Presentation Manager, and Common User Access. Guidelines for user interface designers stress consistency above other considerations. Then there are programs that analyze user interfaces for consistency or even *generate* consistent interfaces, and "user interface management systems" designed to facilitate consistency by isolating the user interface code.

Have we gone too far? I think so. Granted, it's annoying if a new keyboard has the Escape key in an unfamiliar location. And although we may not care whether we perform a certain function by single-clicking or double-clicking, we'd like every application to do it the same way. But "consistency" is an unreliable guide. Some consistent designs are bad, and others are adequate but less than ideal. The greatest danger is that advocating user interface consistency can distract designers from the best approach to design: learning as much as possible about the application's eventual users.

One problem with the notion of consistency is that the designer must determine what aspect should be consistent—often a very difficult choice. (An extreme example: spelling every word backward would be consistent, but a foolish consistency.) In many cases, the issue is subtle: If you're abbreviating a set of command names, should you use truncation (e.g., "de" for "delete"), vowel deletion ("dlt"), or a single-letter strategy ("d")? It depends on how the abbreviations will be used. If the user is to type the commands from memory, truncation is better. If he or she will read the abbreviation—on a key cap, for example—vowel deletion is better and a longer abbreviation is OK. If the user will type the abbreviation many times, or be presented with a menu, a single-letter strategy that minimizes keystrokes might be best.

Working in product development, I've found that my fellow software engineers often use the consistency argument to justify bad designs. In particular, they may want the interface to be consistent with the underlying software architecture and terminology—thus, for example, designing error messages that contain terminology or code numbers that are meaningful to programmers but confusing to users.

Sometimes, *no* consistency (as we usually think of it) helps with design. Consider the typewriter keyboard. The first keyboard, over a century ago, was laid out alphabetically. Many calculators also used alphabetic keyboards. After all, that's consistent with how we learn and often see the letters of the alphabet. But the most efficient keyboard designs are based on careful studies of the hands and fingers, of how our motor control system works in typing, and on characteristics of our language.

Another example: When a pop-up menu appears, should the default menu item be the choice that will be easiest for the user? The first system I used consistently defaulted to the first item in the menu. After that, I used a system that consistently defaulted to the item that I had last chosen—this was often what I wanted, and I liked it.

But now I use an even better system, one that uses *no* consistent default algorithm. In many cases, it defaults to my most recent choice. Sometimes, though, it alternates: If I choose Copy, the next time I bring up that menu, it defaults to Paste—which is usually what I want to do. At other times, the system may suspect what I want to do but refuses to default to it. For example, when I select a dangerous operation, a menu appears with Confirm or Cancel as choices. Even though I almost always choose Confirm, it always defaults to Cancel.

What about the clear benefits that Apple has reaped from its consistent interface? Here, too, consistency might prove to be a hindrance in the long run. Certain features of the Macintosh were optimized for the original small, single-task display.

Take the menu bar at the top of the Mac display. With larger displays and multiple windows, moving to the menu bar takes longer. Users might also be confused as to which application controls the menu bar. Other menu designs may prove to be better for large displays. In fact, HyperCard's "tear-off" menus are a crack in the wall of Macintosh pull-down menu consistency.

This is not to pick on the trailblazing Macintosh interface, just a reminder that designers can never rest on past achievements. Consistency makes sense only if it makes users' work easier. ■

Jonathan Grudin has developed and published articles on user interfaces for several years. Currently on leave from the Microelectronics and Computer Technology Corp., he is teaching at Aarhus University in Denmark. He can be reached on BIX c/o "editors."

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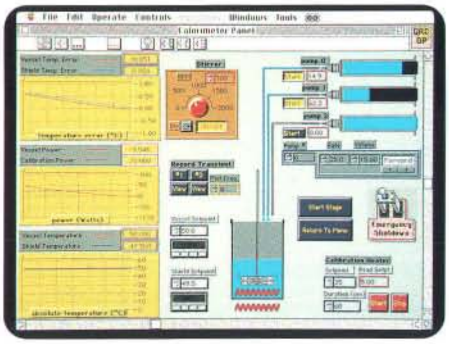
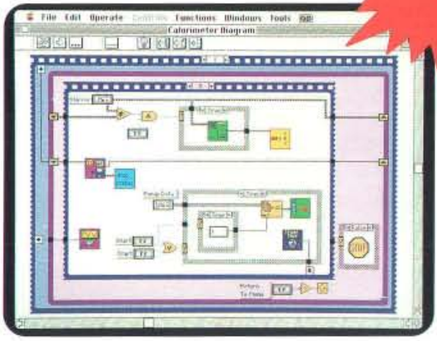


LabVIEW 2 front panel user interface



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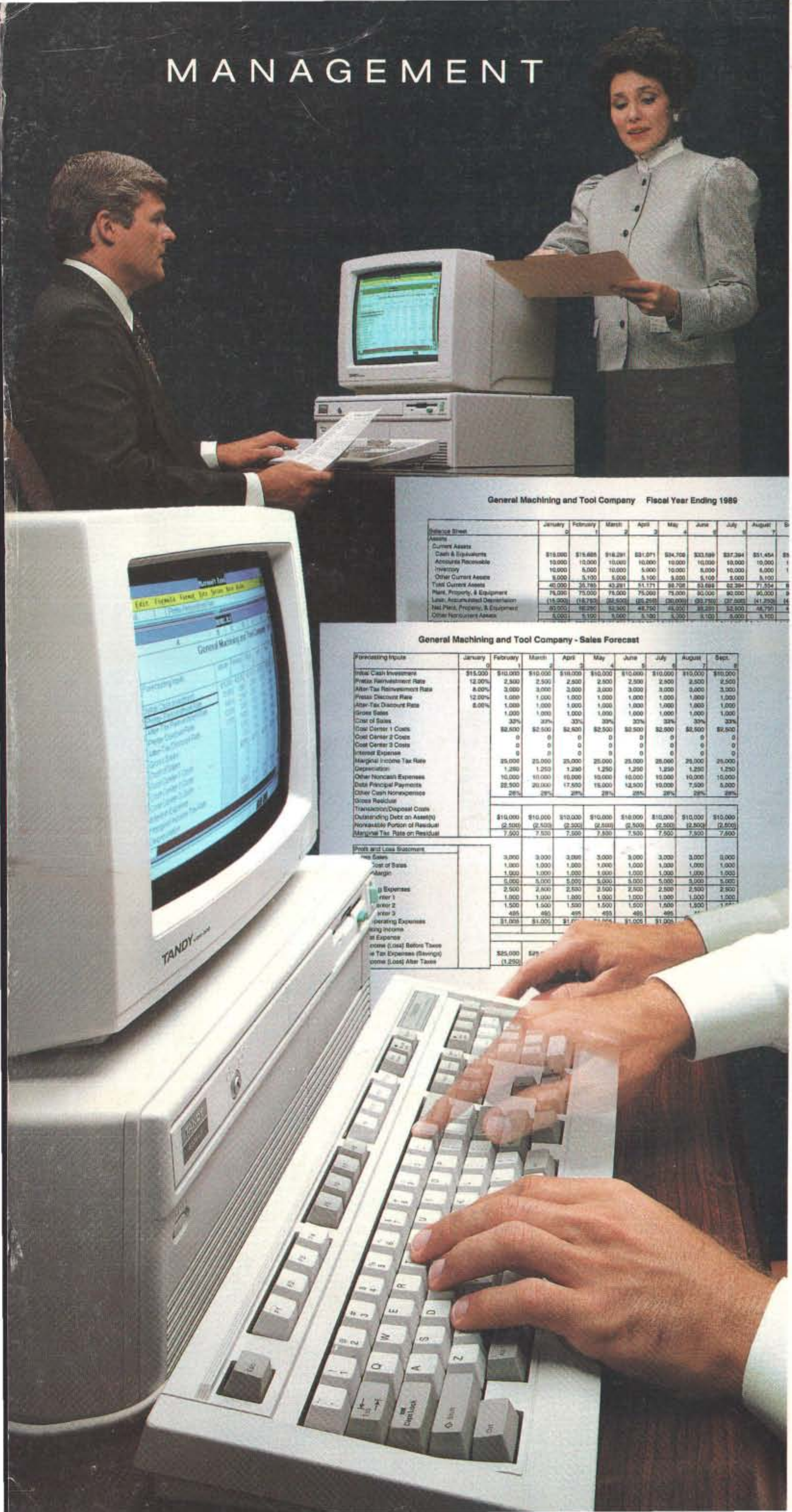
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